New Insights in the Geodynamic Evolution of the Atlantic Margin Offshore Essaouira (Morocco)*

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Abstract

This study is based on recently acquired 2D seismic reflection data of the 2011 MIRROR experiment. It focuses on seismic-based structural analysis and provides new insights into the Late Cretaceous to Cenozoic geodynamic evolution of the Atlantic margin offshore Morocco. The prominent Base Tertiary Unconformity (BTU) is related to a regional hiatus and is interpreted to have formed earlier in the northern study area (approx. Cenomanian age at DSDP 416) and propagated through time to the south (approx. Coniacian age at DSDP 415). Salt canopies are observed in levels at and above the unconformity, and we interpret their emplacement by salt extrusion on the seafloor to be contemporaneous to the hiatus event. We postulate that north-south variations in both the duration of the hiatus and Cenozoic sedimentation rates influenced regional differences in salt preservation: today, salt diapirs dominate the Agadir Basin in the south of the study area, and the Ras Tafelnay Plateau is characterized by massive salt canopies; in contrast, in the north, where the hiatus lasted longer and the Cenozoic sediment cover is thinner (offshore Essaouira and Safi Basins), weld structures and associated deformation suggest an important loss of salt in the past, resulting in the preservation of salt-poor canopy remnants only. Furthermore, our interpretation indicates a tectonic reactivation of pre-existing oceanic and syn-rift basement faults during the Early Paleogene. This structural event was accompanied by volcanism and formed a series of deep-water anticlines with associated deformation in the overlying sediments.

By analyzing this deformation, it can be seen that the folding was initiated earlier in the northern study area (around DSDP 416) than in the south (around DSDP 415). Therefore, this study proposes a diachronic southward trend for the basement fault reactivation, similar to the BTU. In conclusion, we postulate a tempo-spatial relation between the relative north-south motion of the Canary Island hotspot, the diachrony of the BTU and the reactivation of basement faults. The major hiatus might indicate a regional Late Cretaceous uplift related to the approaching hotspot, followed by a more local uplift above the hotspot center during the Early Paleogene. The reactivation of basement faults associated with the emplacement of volcanic intrusions is interpreted to result from this latter local uplift.

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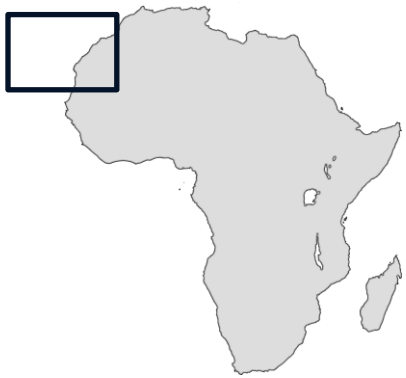
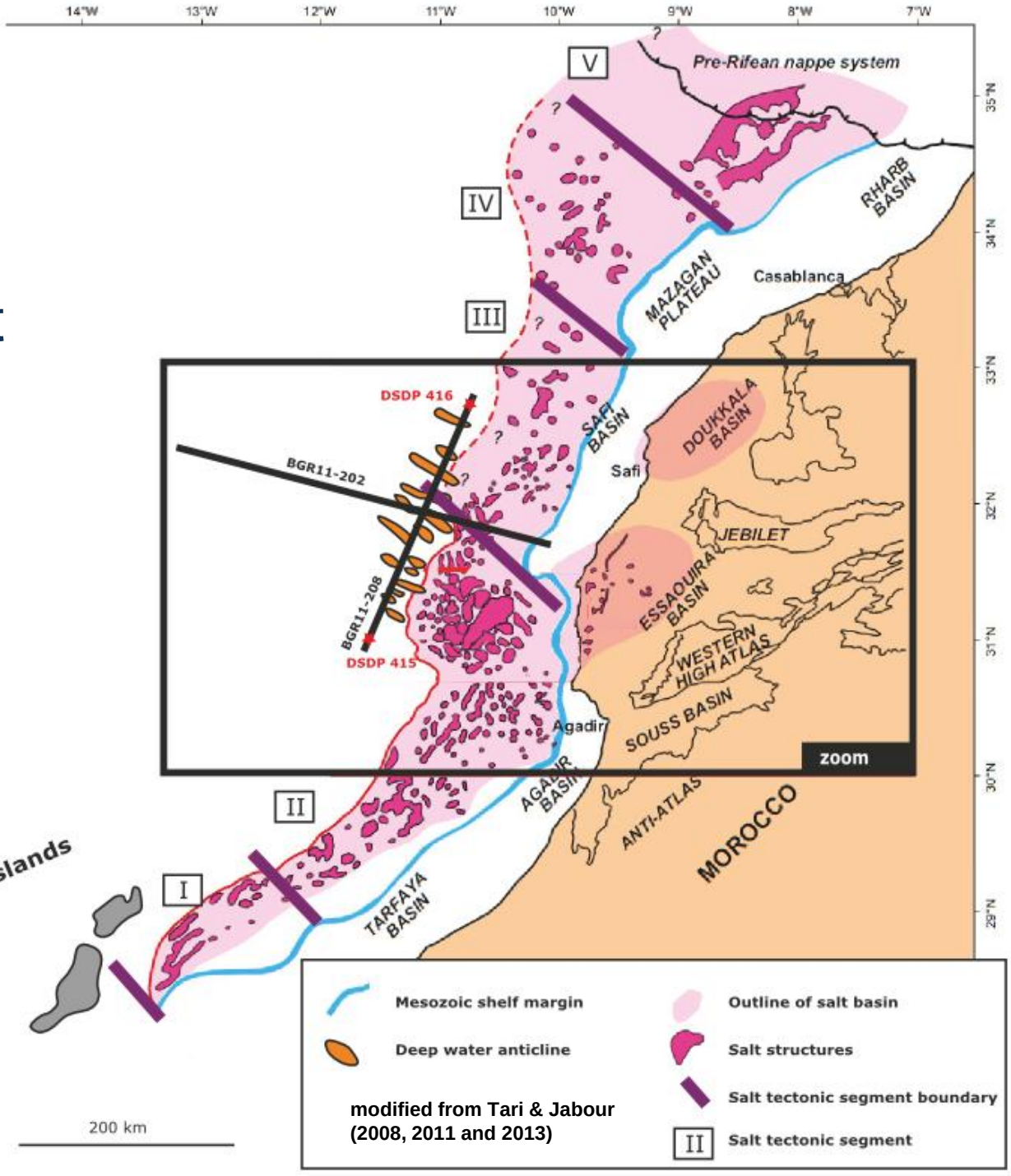
BGR EMR Energy & Mineral Resources Group RWTH AACHEN Schlumberger

Introduction

- Passive Margin
- Atlas Mountain Belt
- Canary Islands

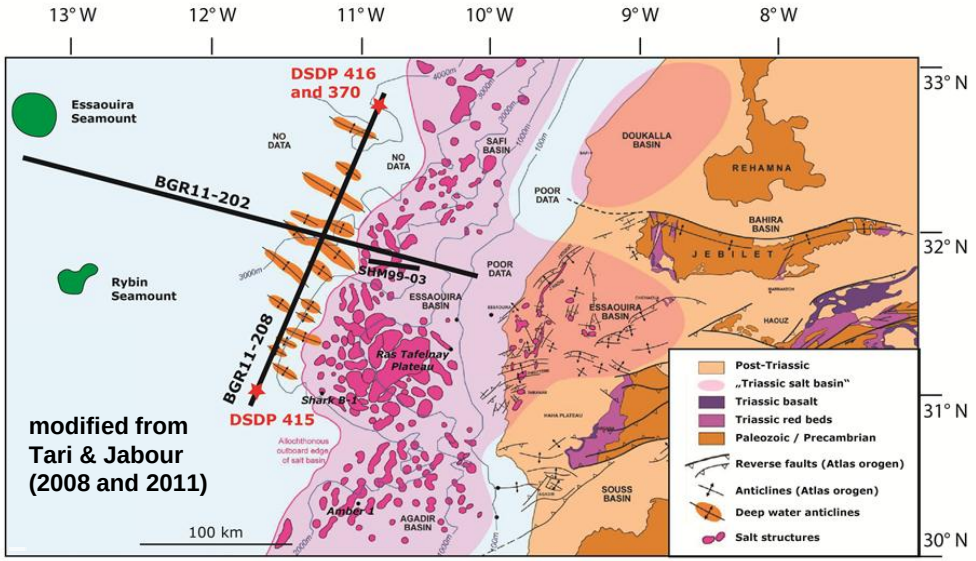


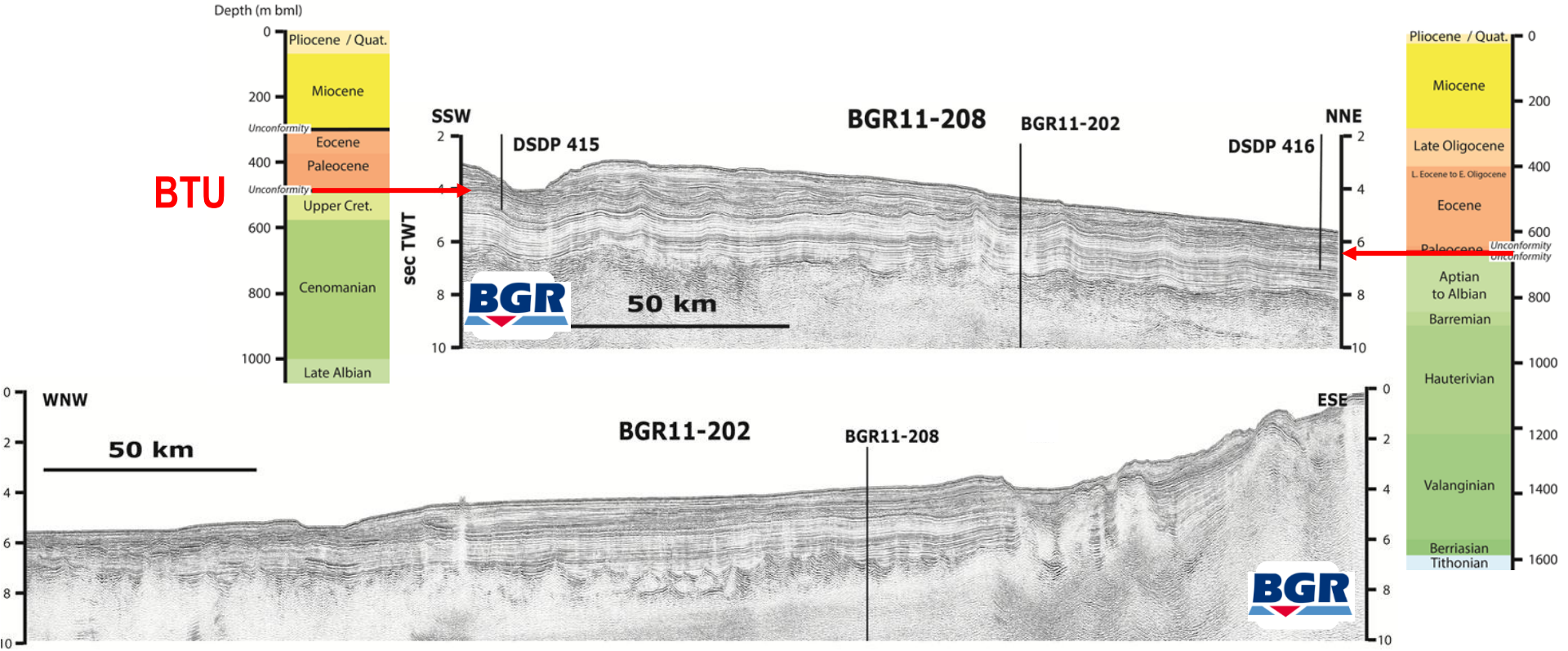


modified from Tari & Jabour (2008, 2011 and 2013)

Introduction

- 2 Research Wells
- BGR11-208 / BGR11-202





Introduction

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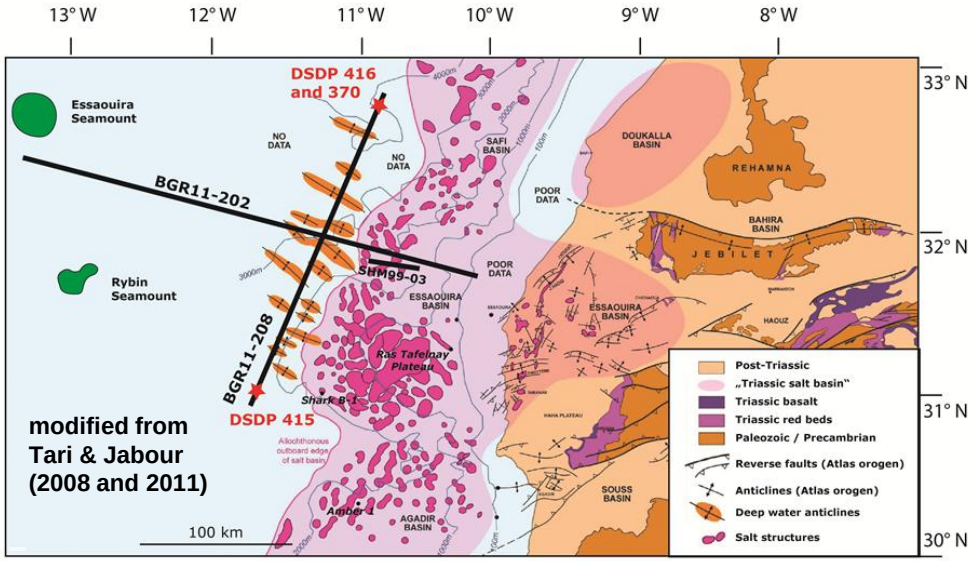

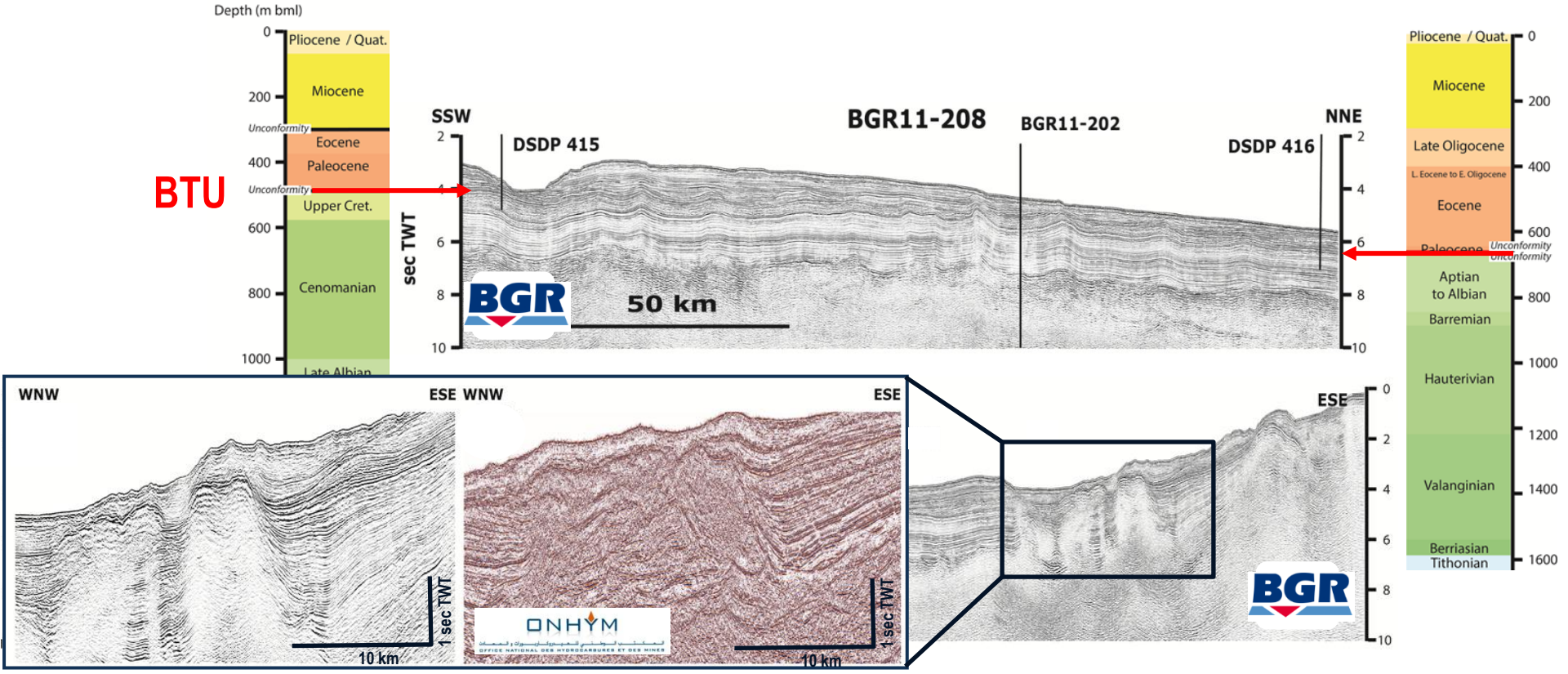

Introduction

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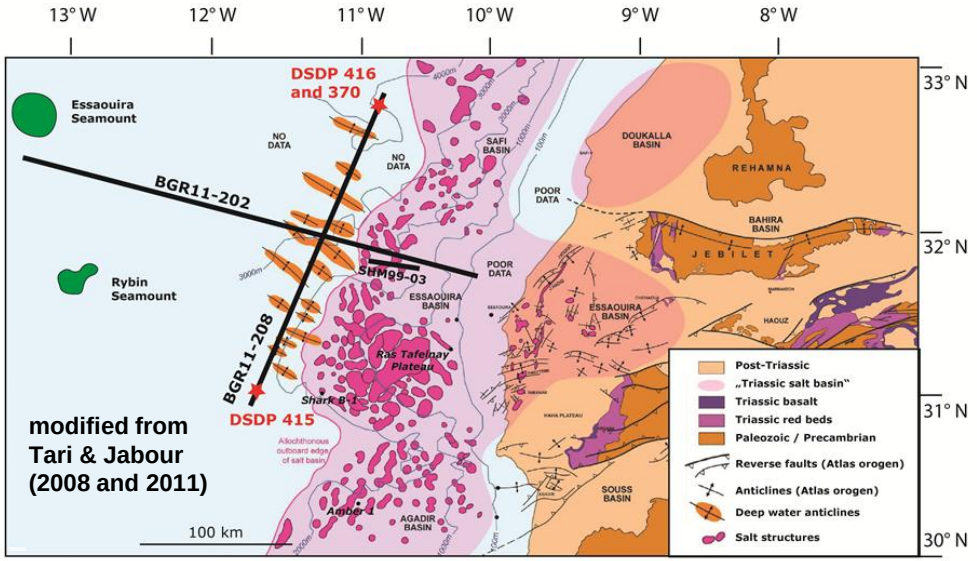
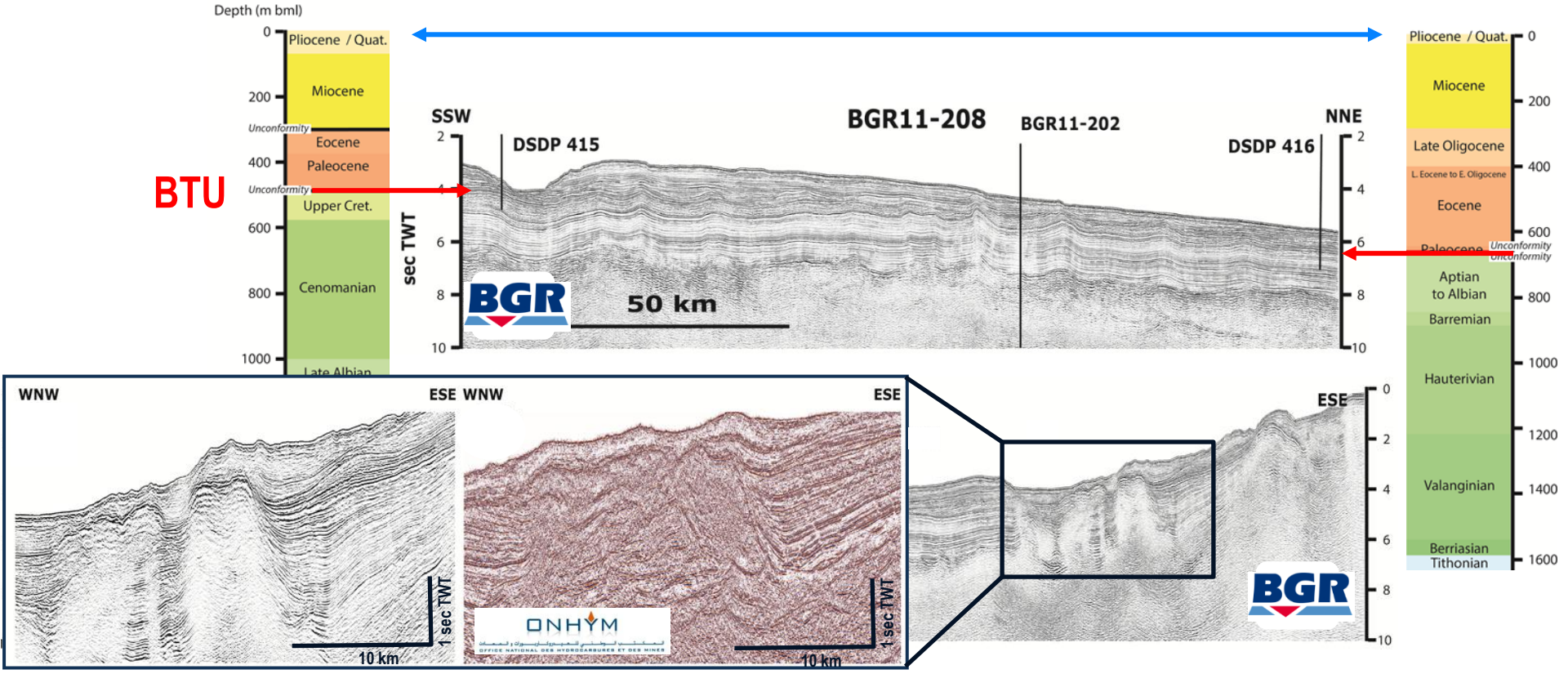
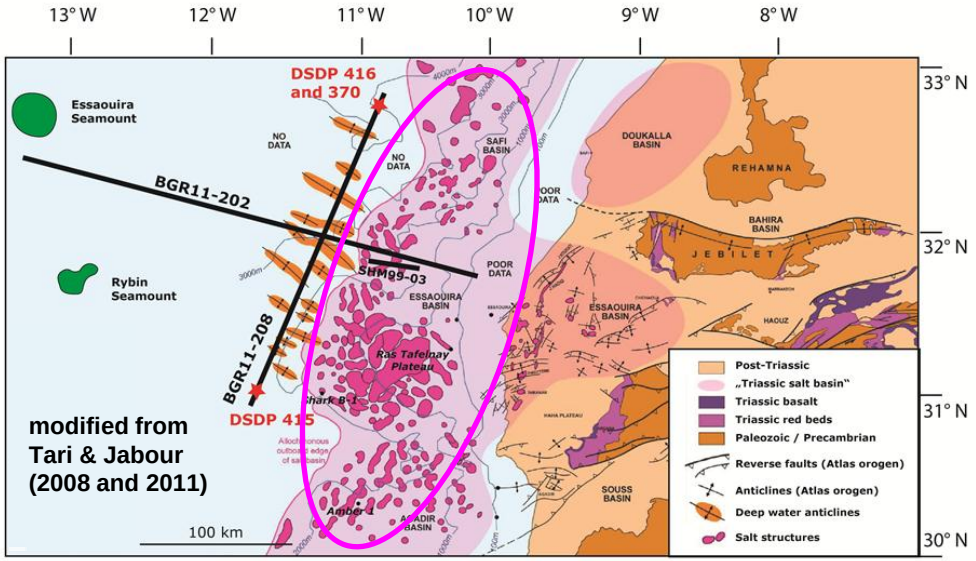
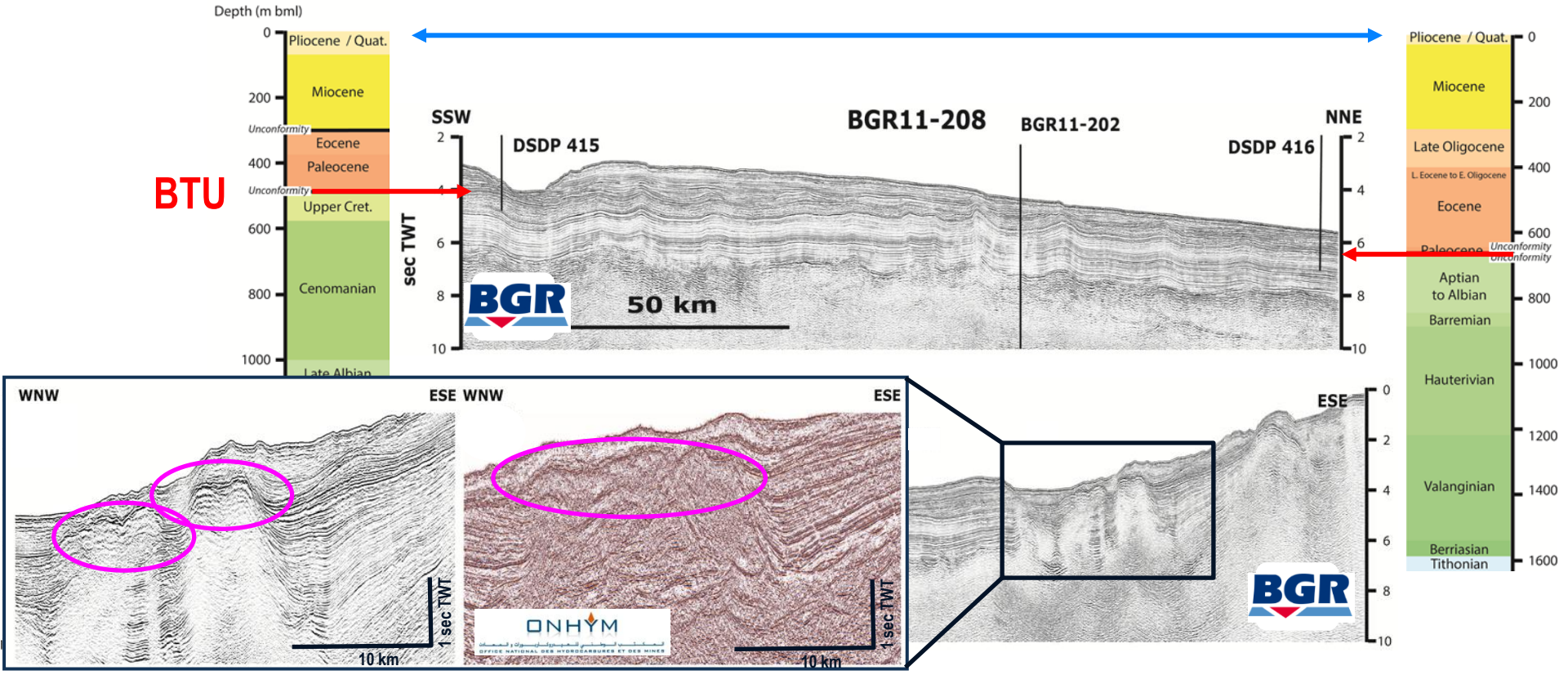




Introduction

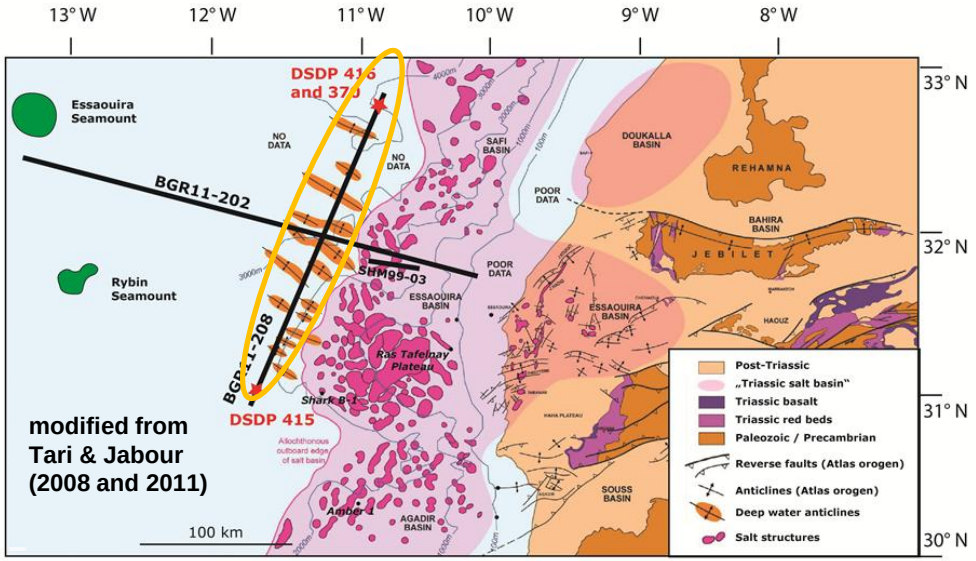
- 1. North-south Variations
- 2. Salt Tectonics

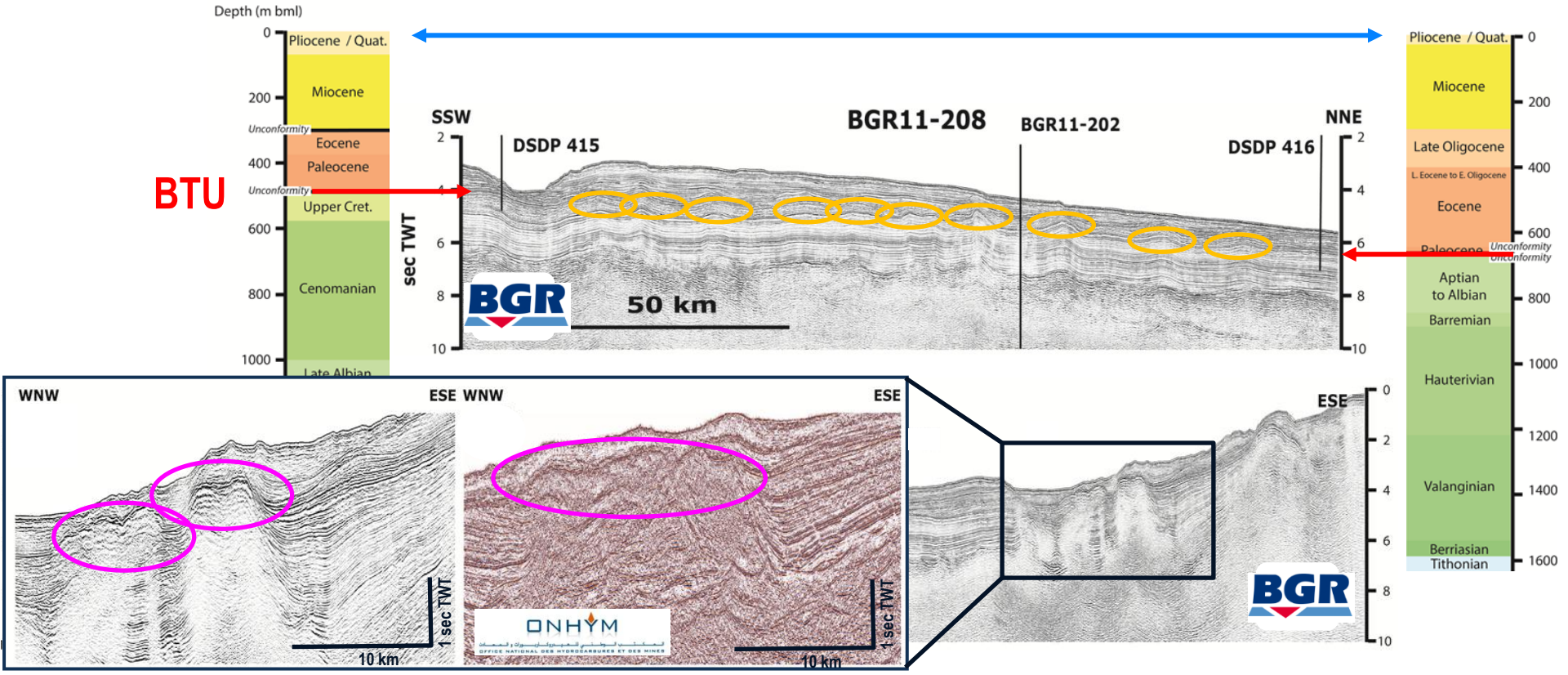




Introduction

- 1. North-south Variations
- 2. Salt Tectonics
- 3. Deep-water Folds





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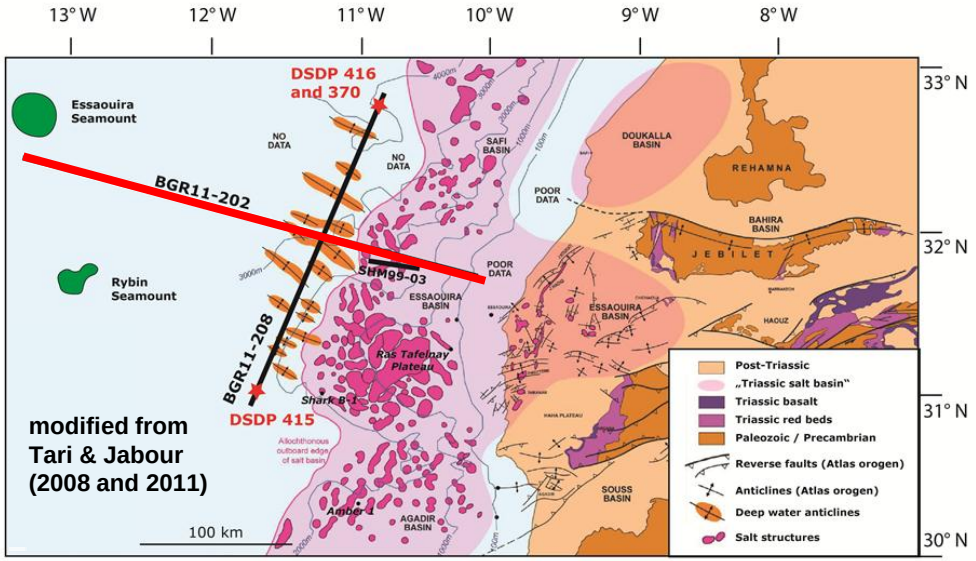

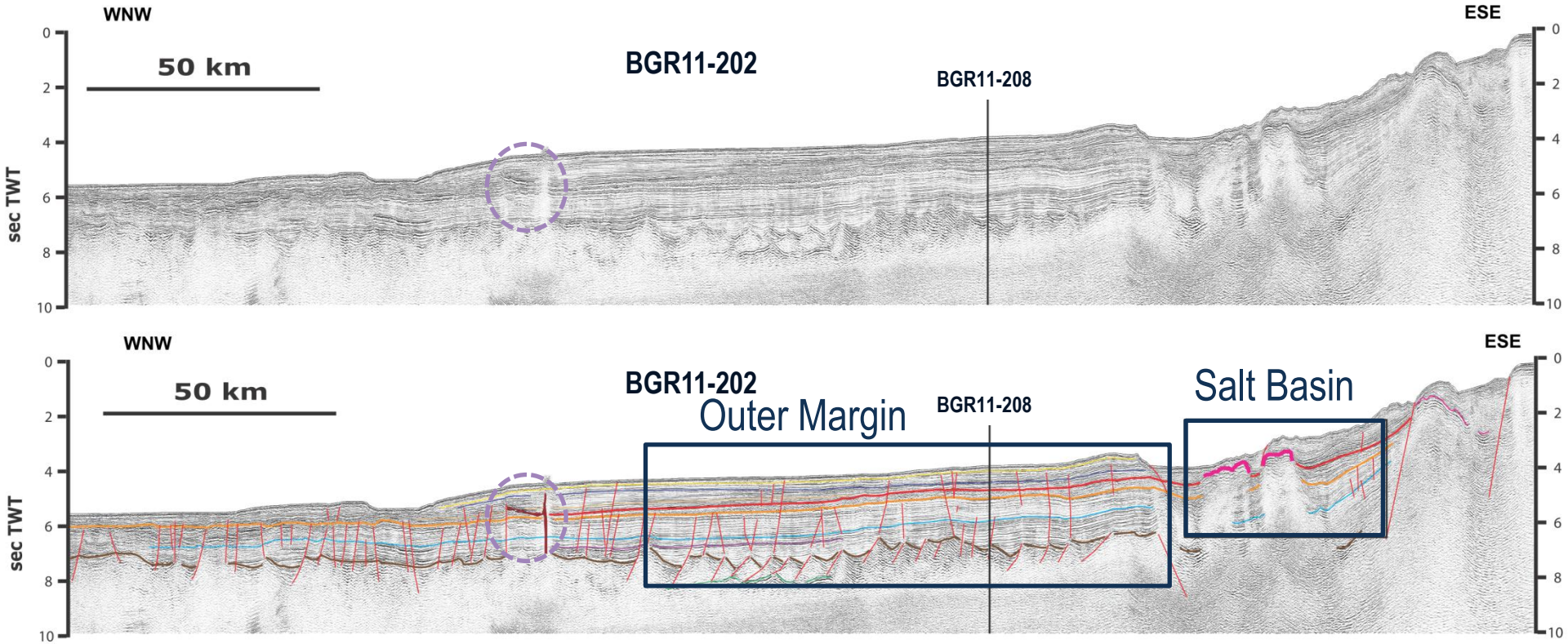

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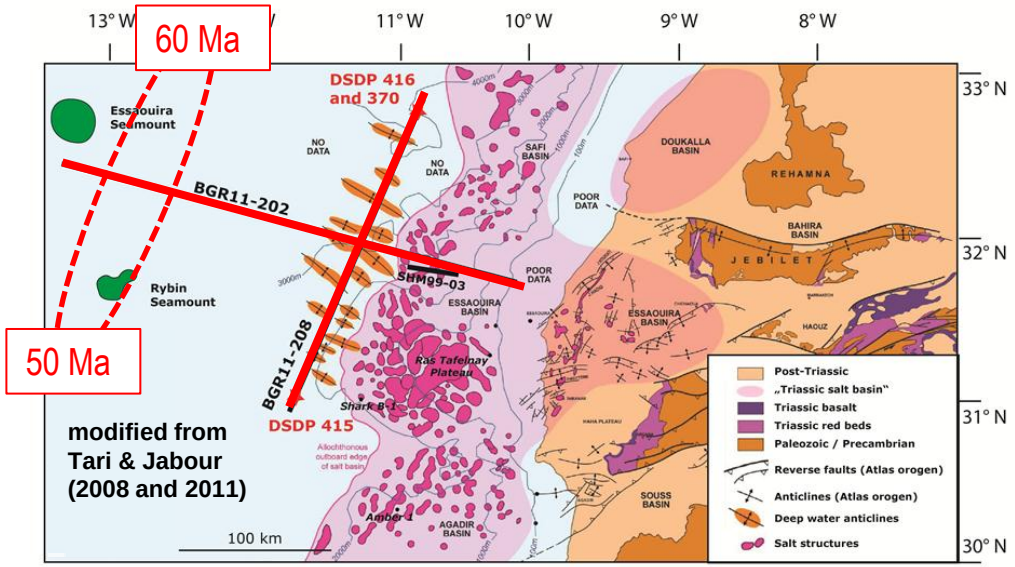

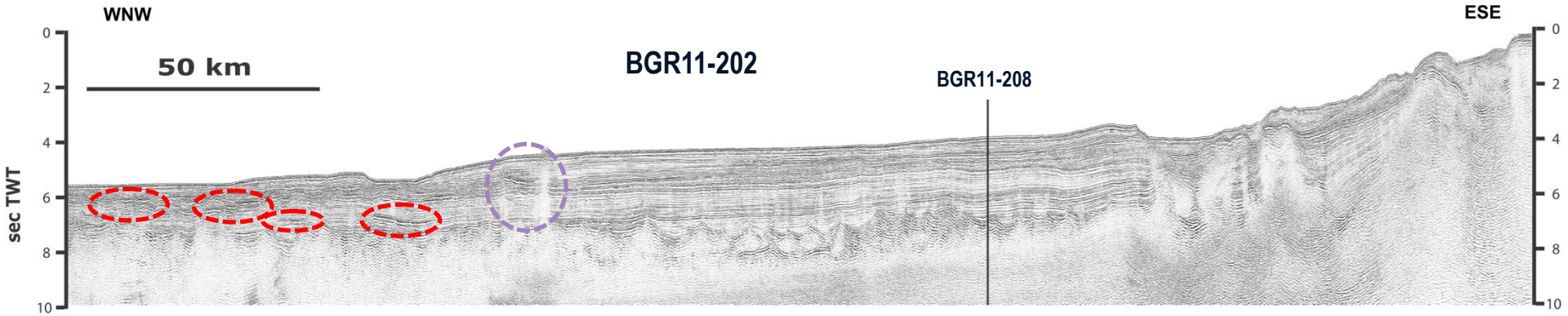

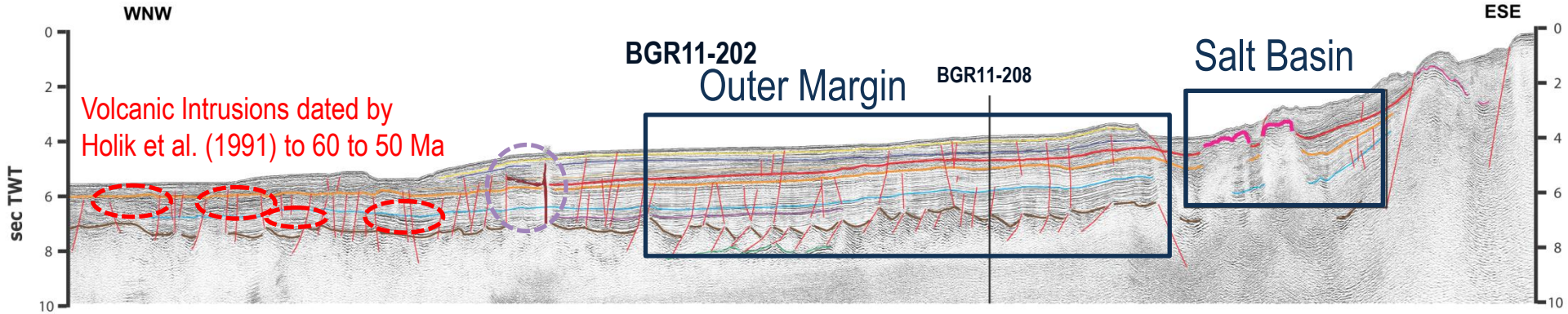

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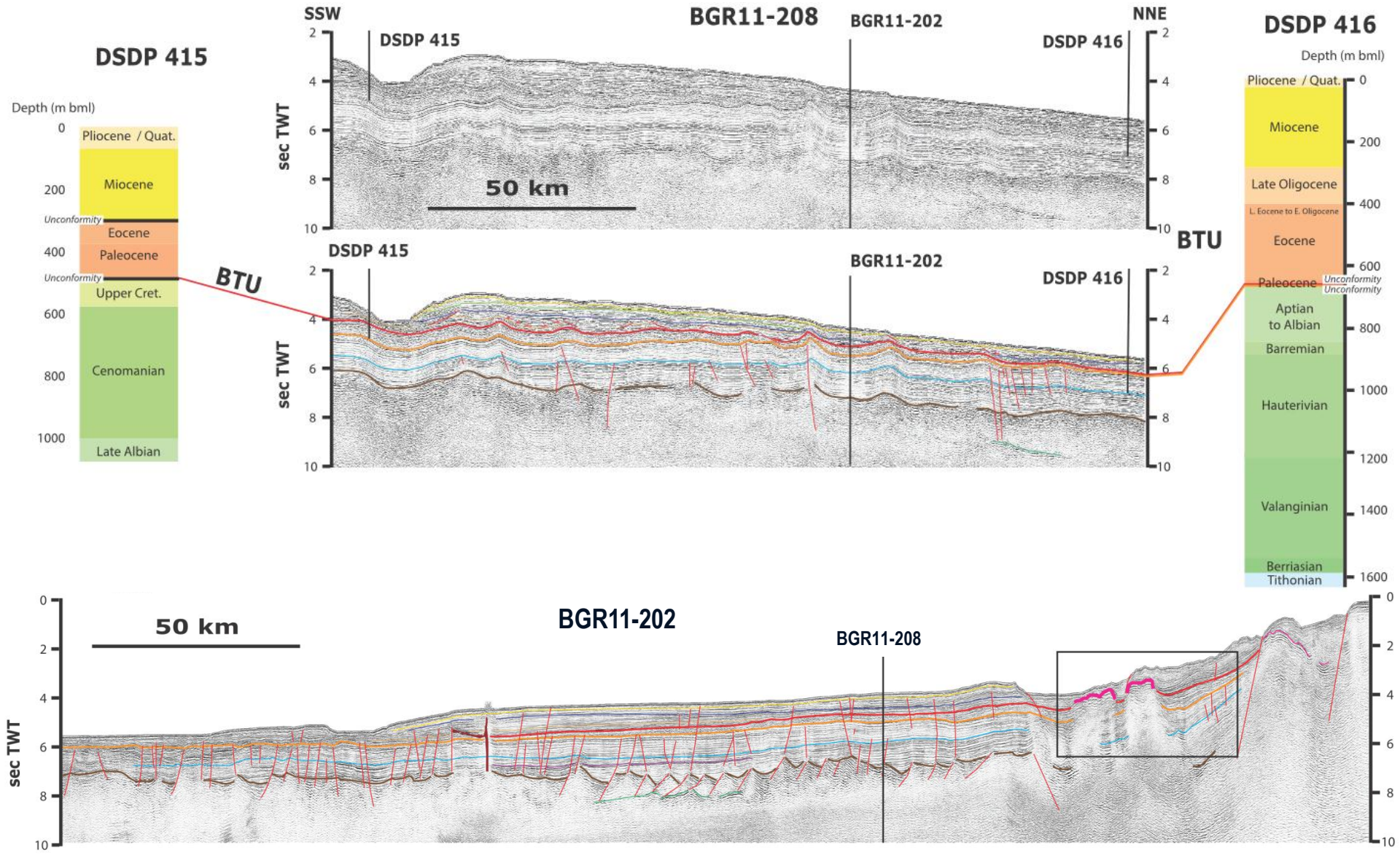

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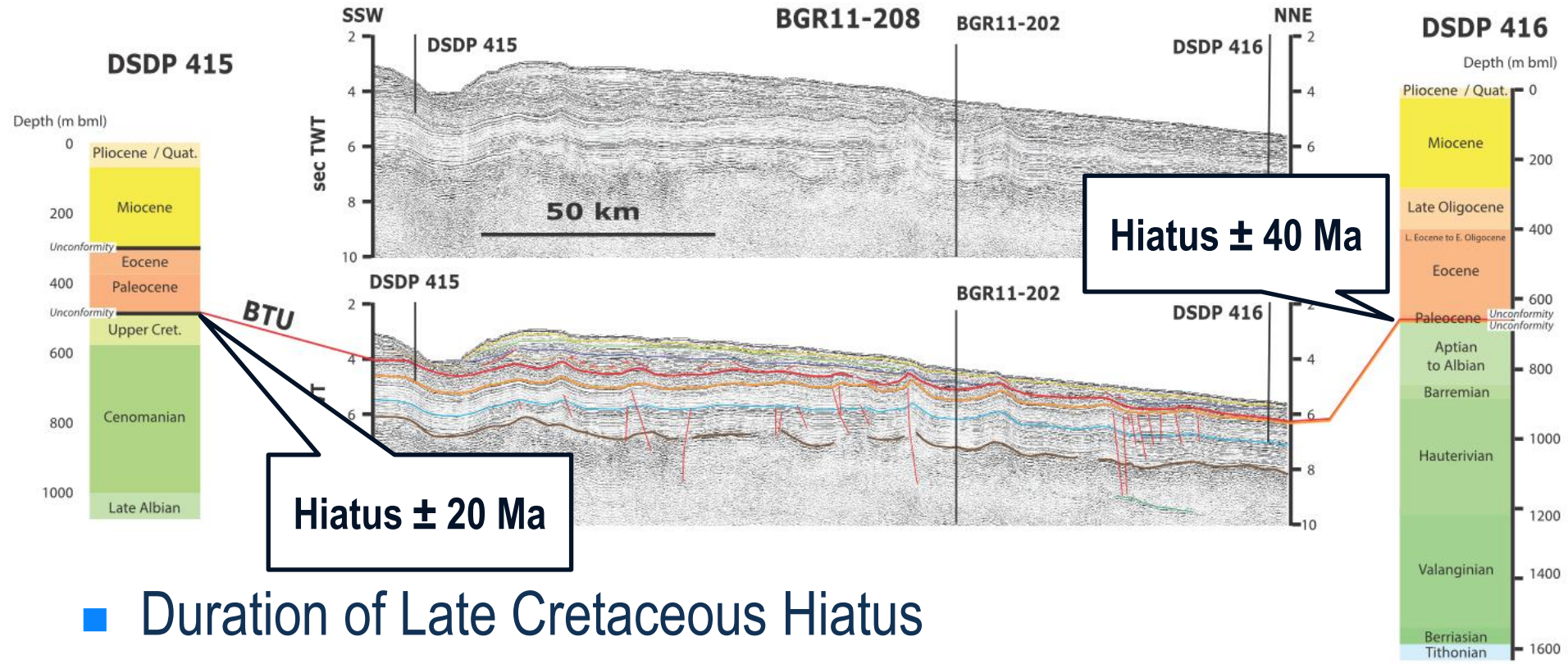

- Duration of Late Cretaceous Hiatus

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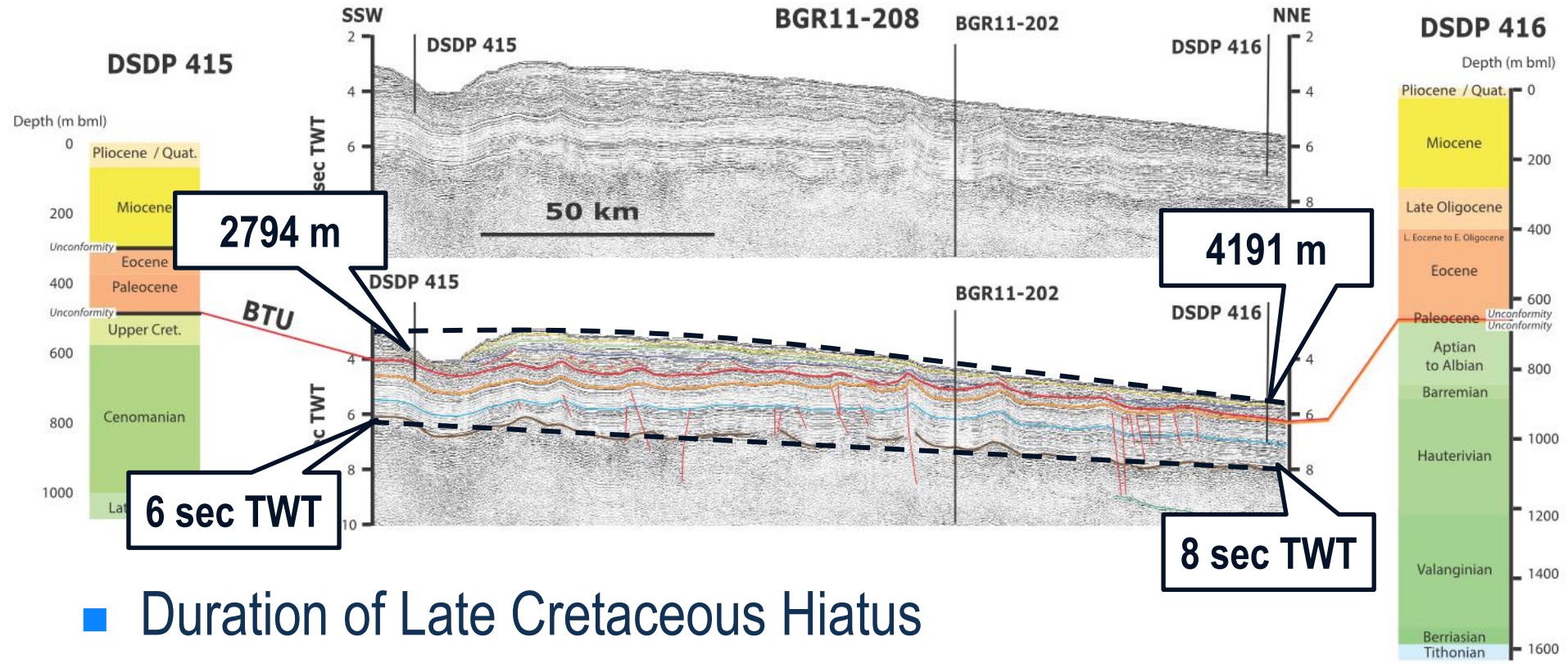
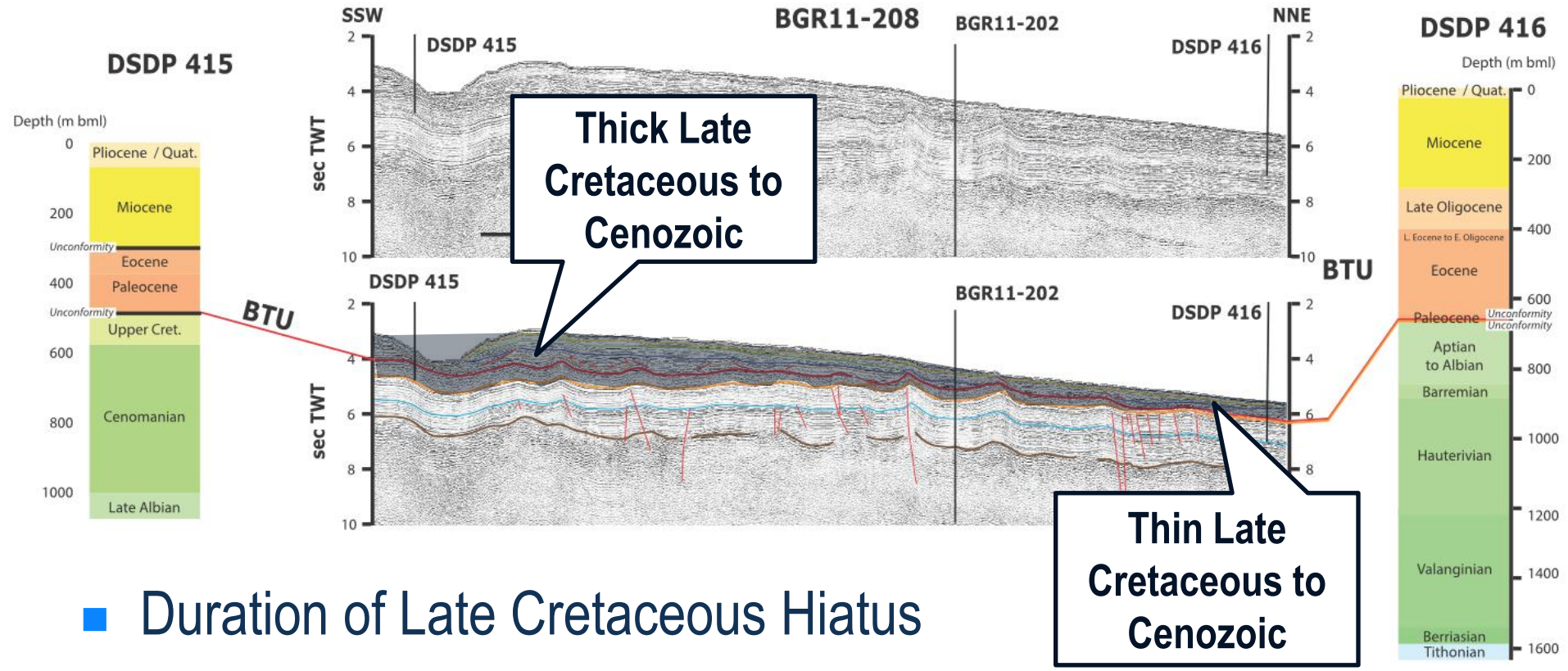


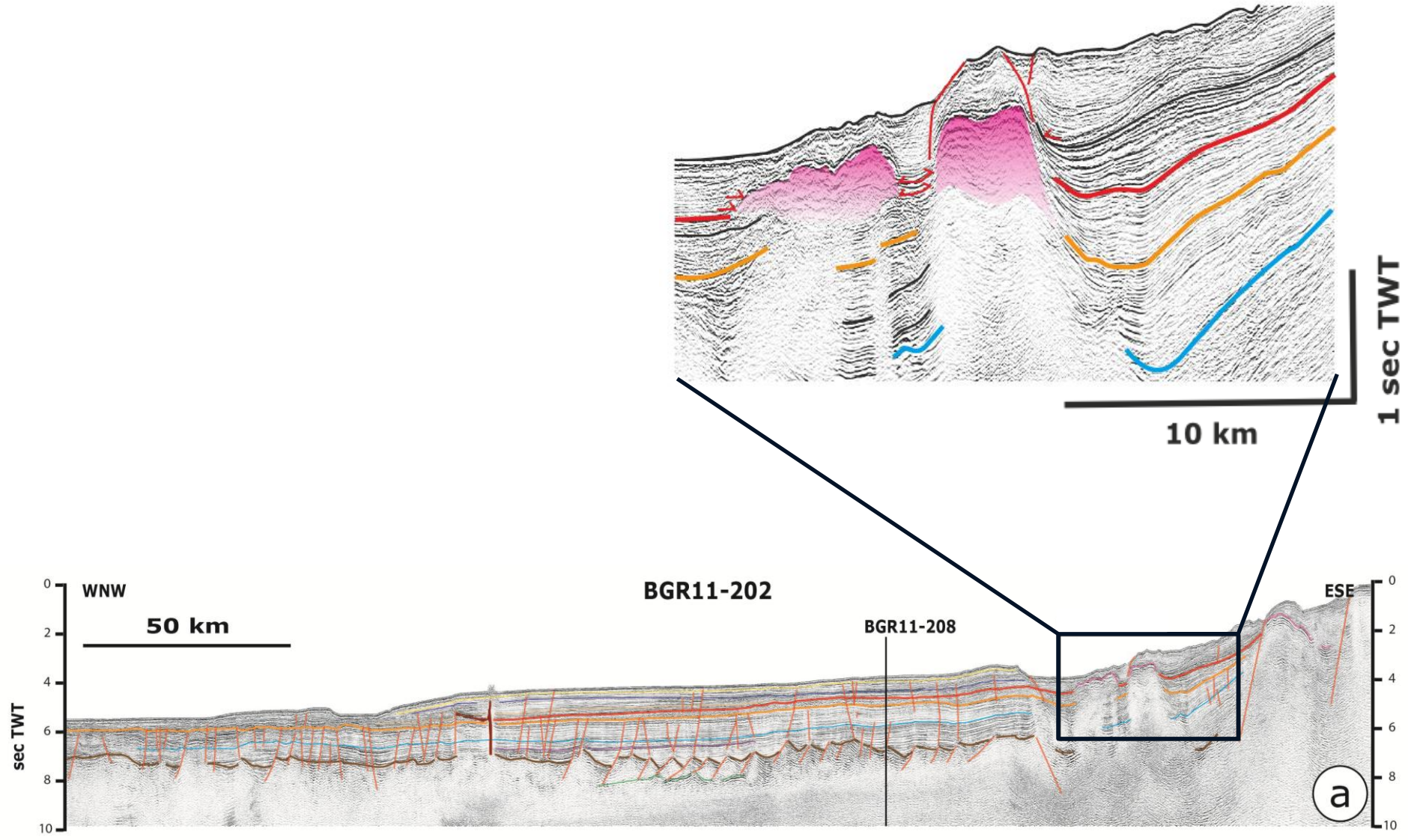
- Duration of Late Cretaceous Hiatus
- Water Depth and Basement Depth

1. North-south Variations



- Duration of Late Cretaceous Hiatus
- Water Depth and Basement Depth
- Late Cretaceous and Cenozoic Thickness

2. Salt Tectonics



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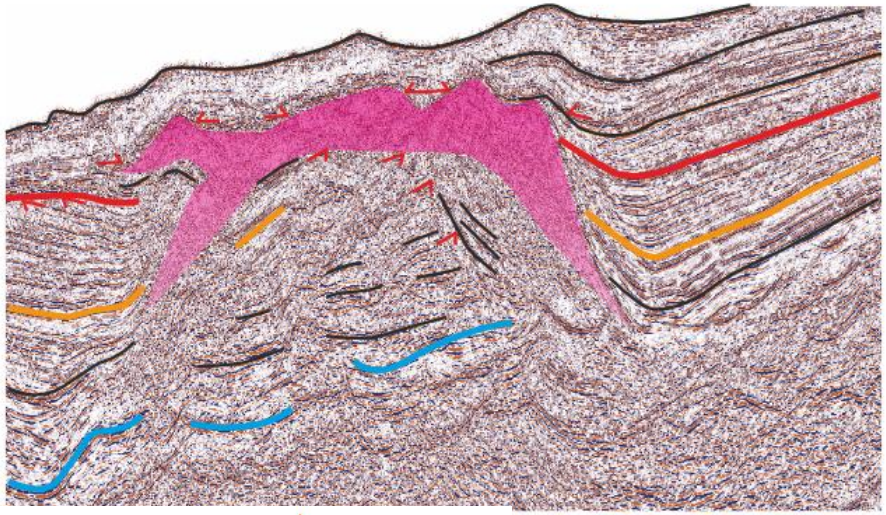

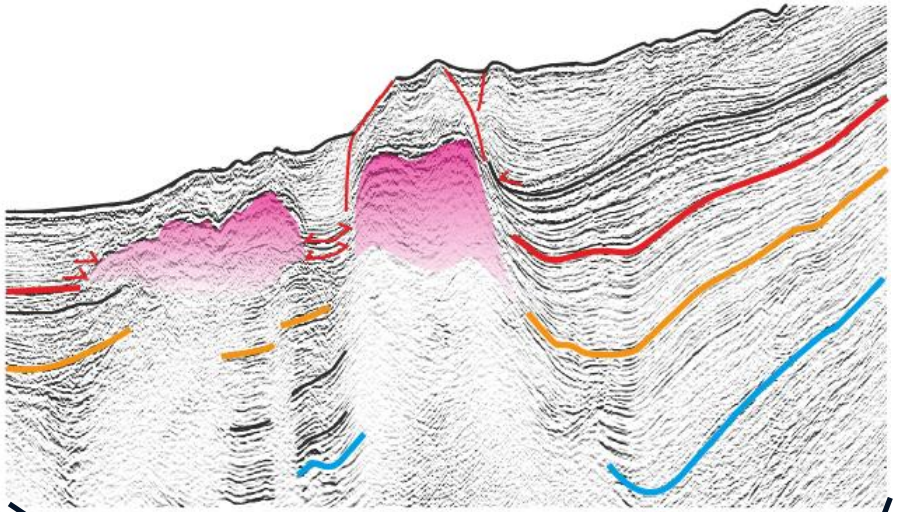

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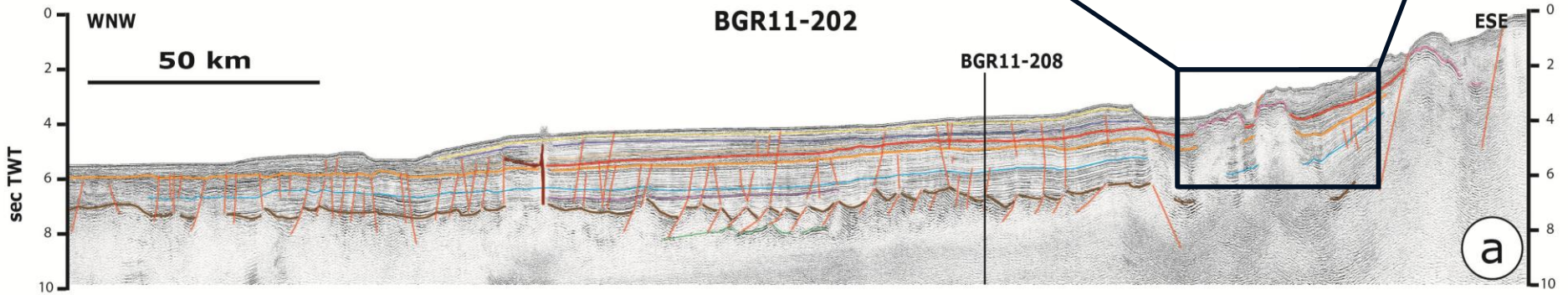
OFFICE NATIONAL DES HYDROCARBURES ET DES MINES



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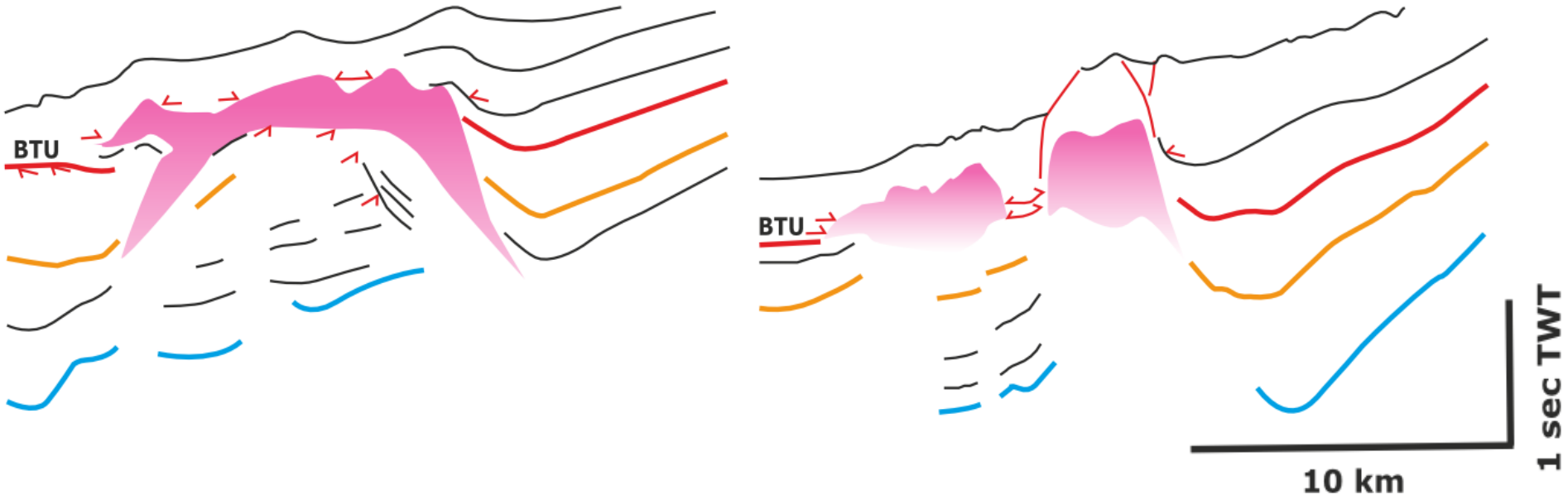

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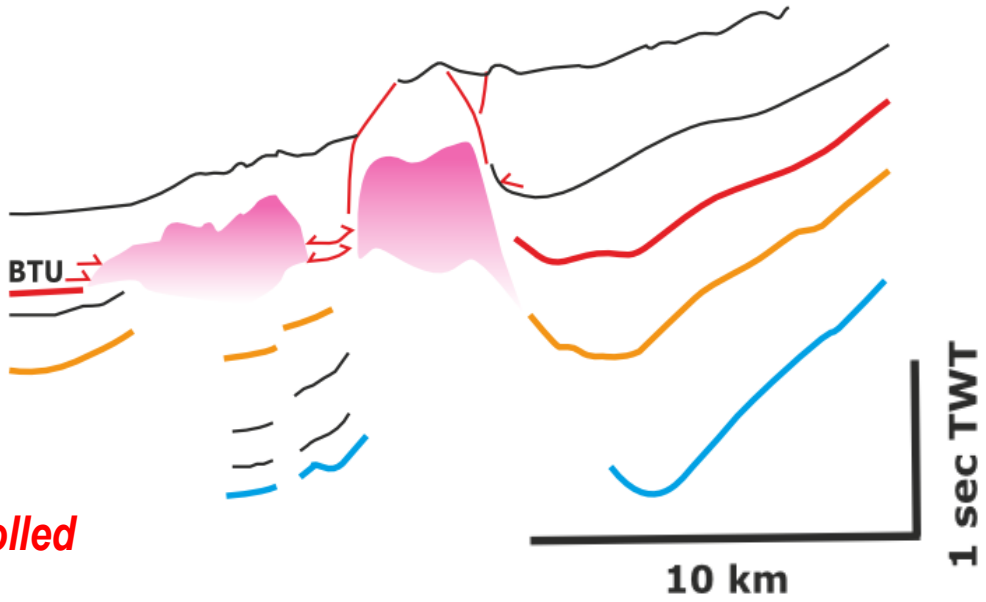
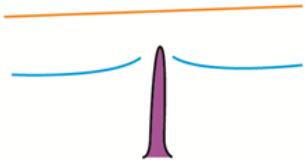


Extrusion controlled by burial?

Middle Jurassic to Early Cretaceous

Continuous burial



Diapiric salt rise

Cenomanian to Coniacian (?)

Late Cretaceous

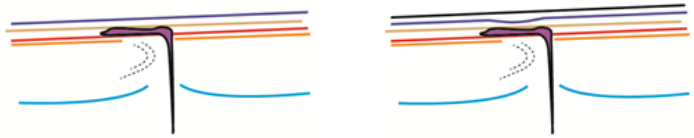
Sedimentation hiatus

Submarine salt extrusion

Massive dissolution and cap rock building

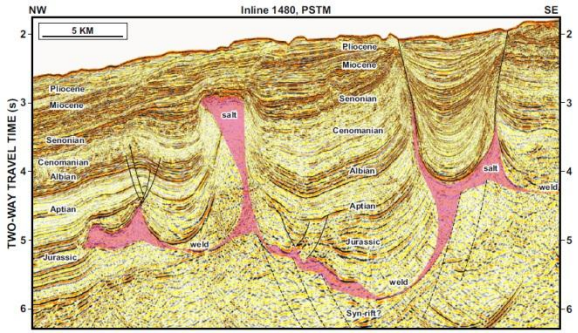
Cenozoic

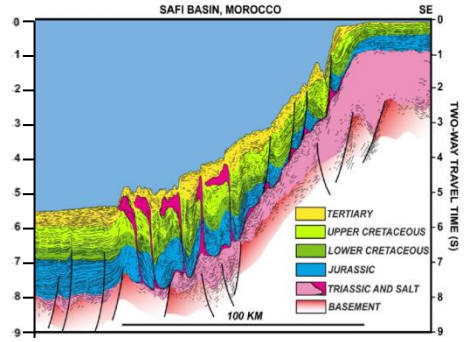
Minor burial



Limited remobilization

2. Salt Tectonics





Tari & Jabour (2008)

Tari & Jabour (2013)

modified from Tari & Jabour (2008, 2011 and 2013)

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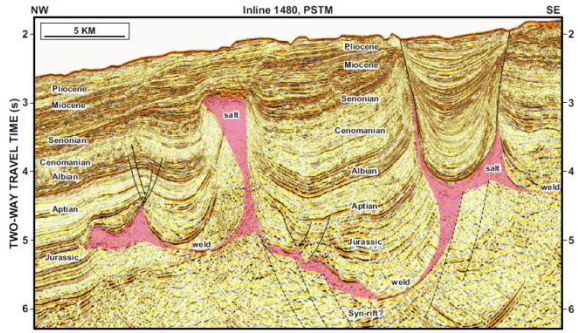
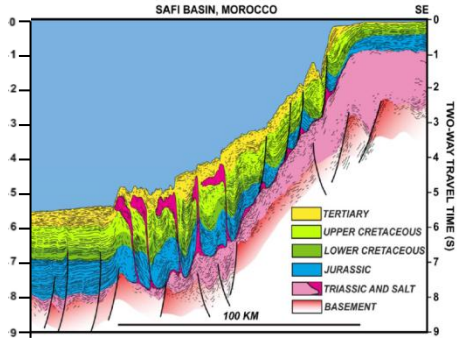
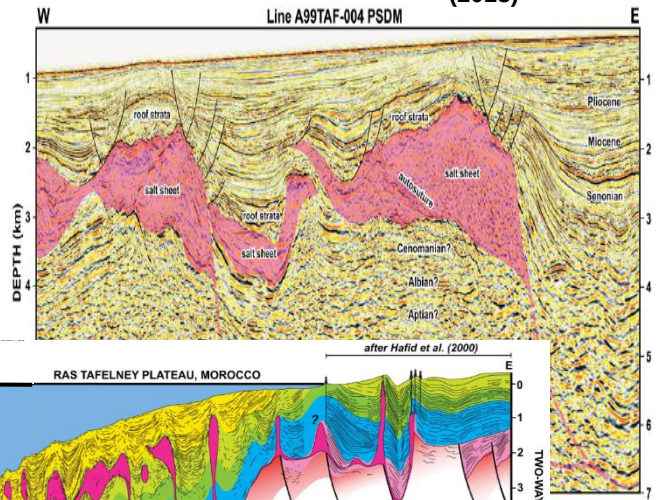
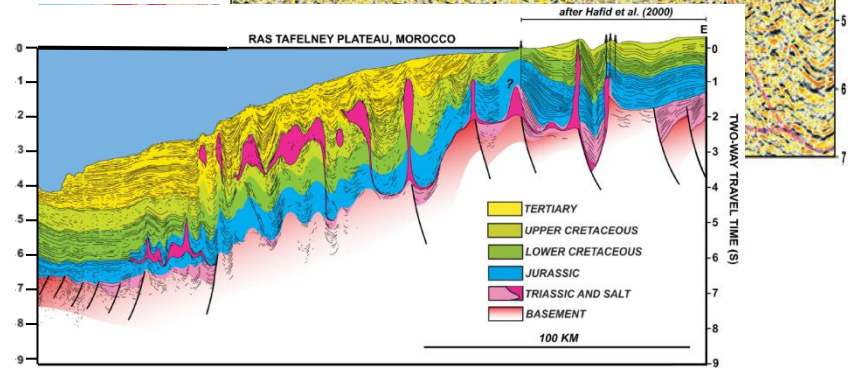




Tari & Jabour (2008)

Tari & Jabour (2013)





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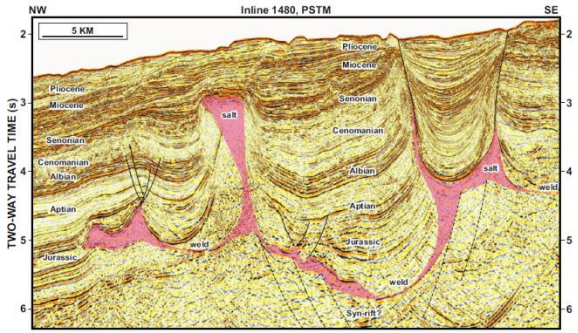

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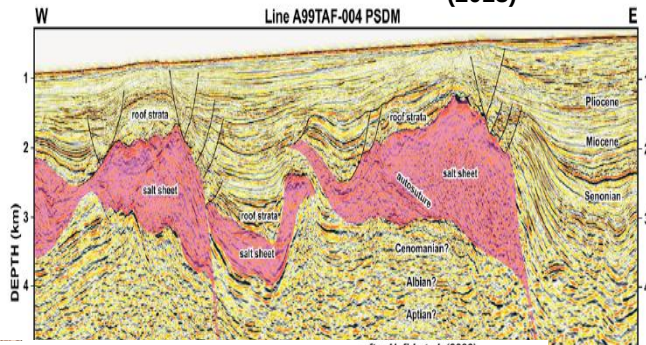

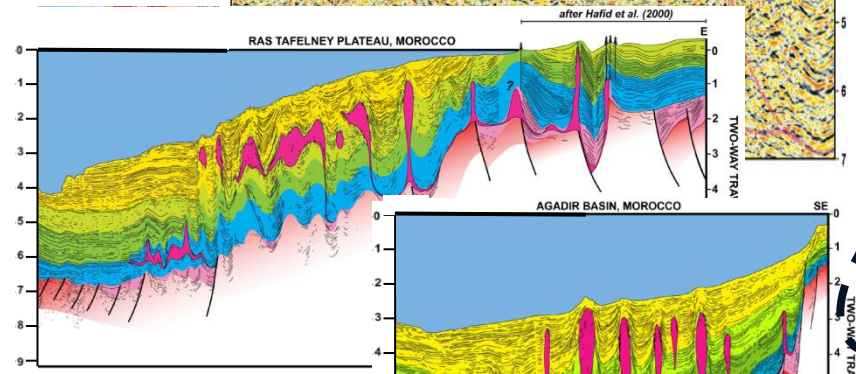

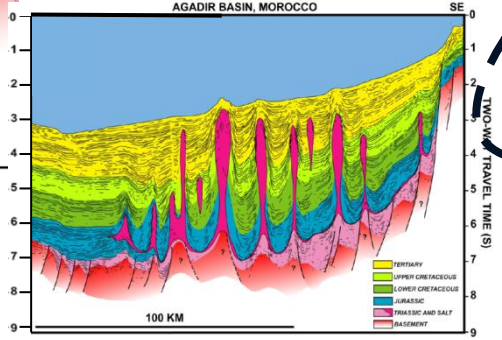

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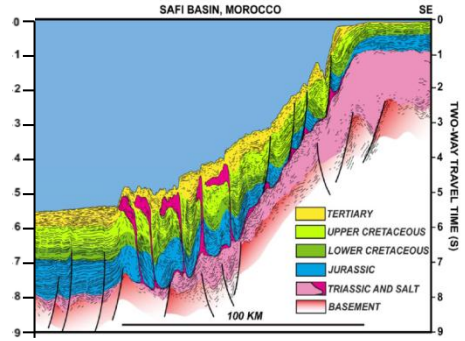

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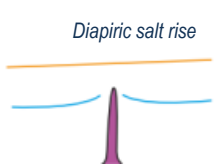
modified from Tari & Jabour (2008, 2011 and 2013)

2. Salt Tectonics

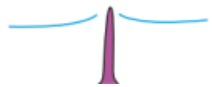
Continuous burial

Diapiric salt rise



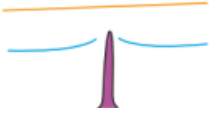
Continuous burial

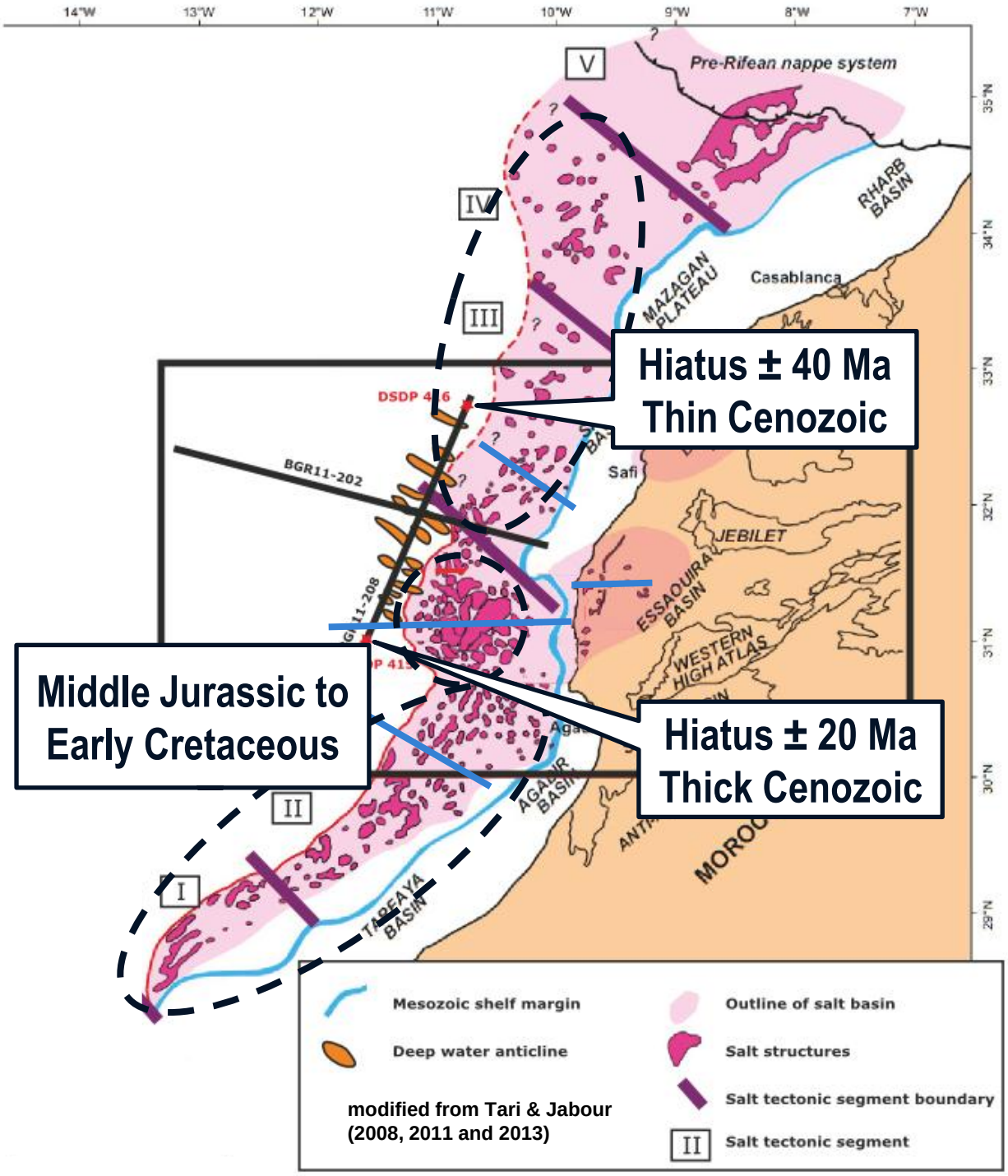
Diapiric salt rise



Continuous burial

Diapiric salt rise





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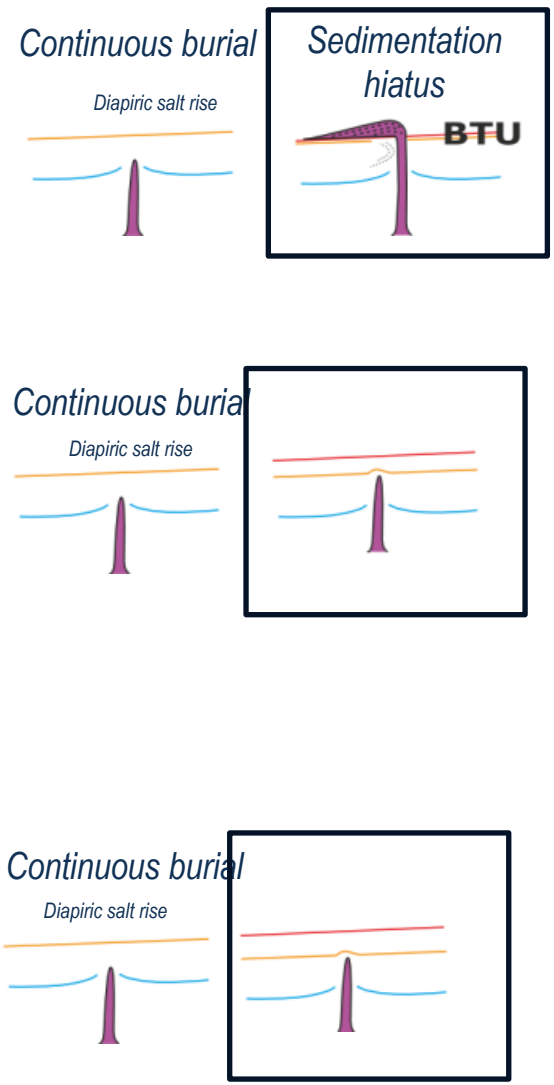

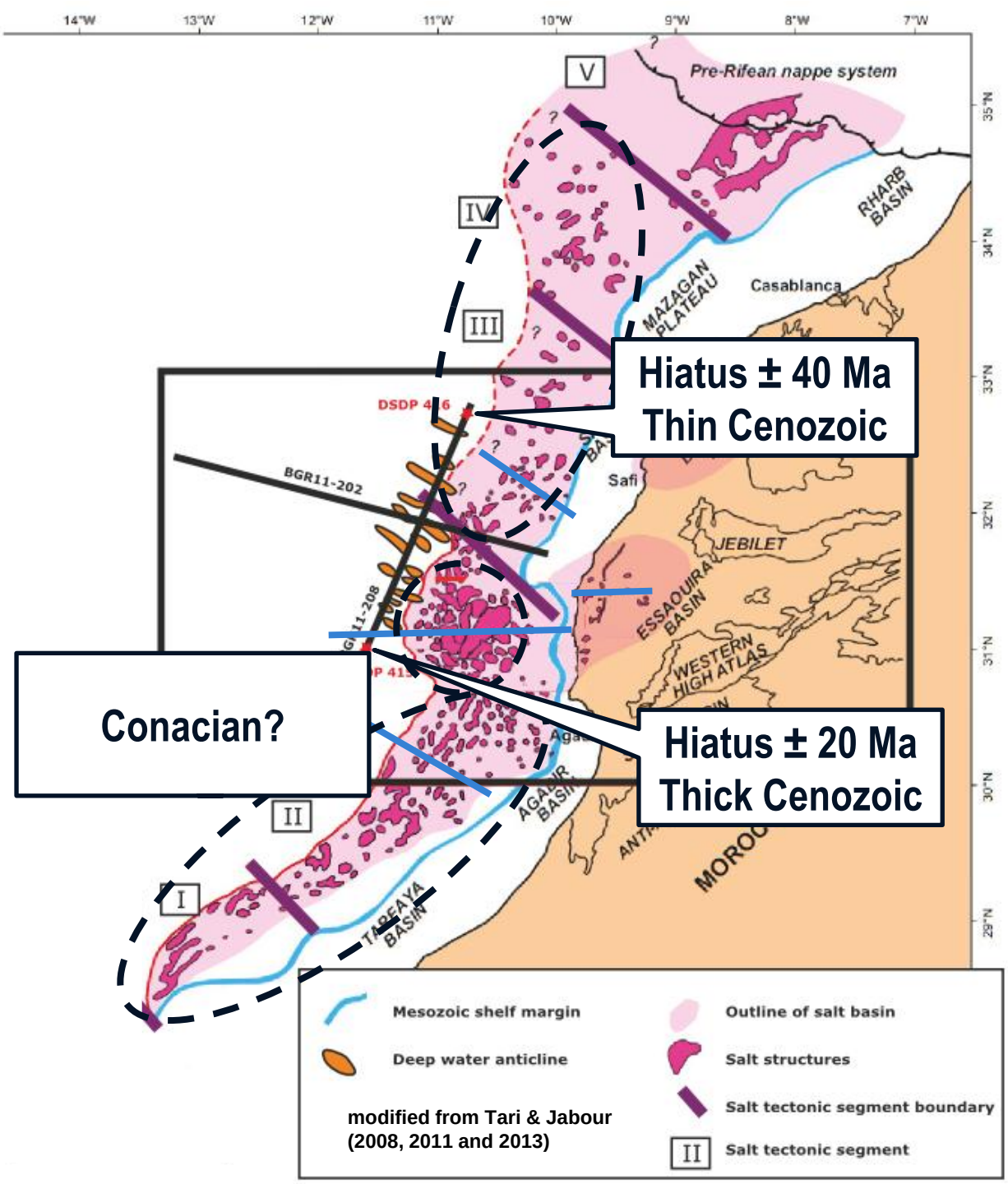

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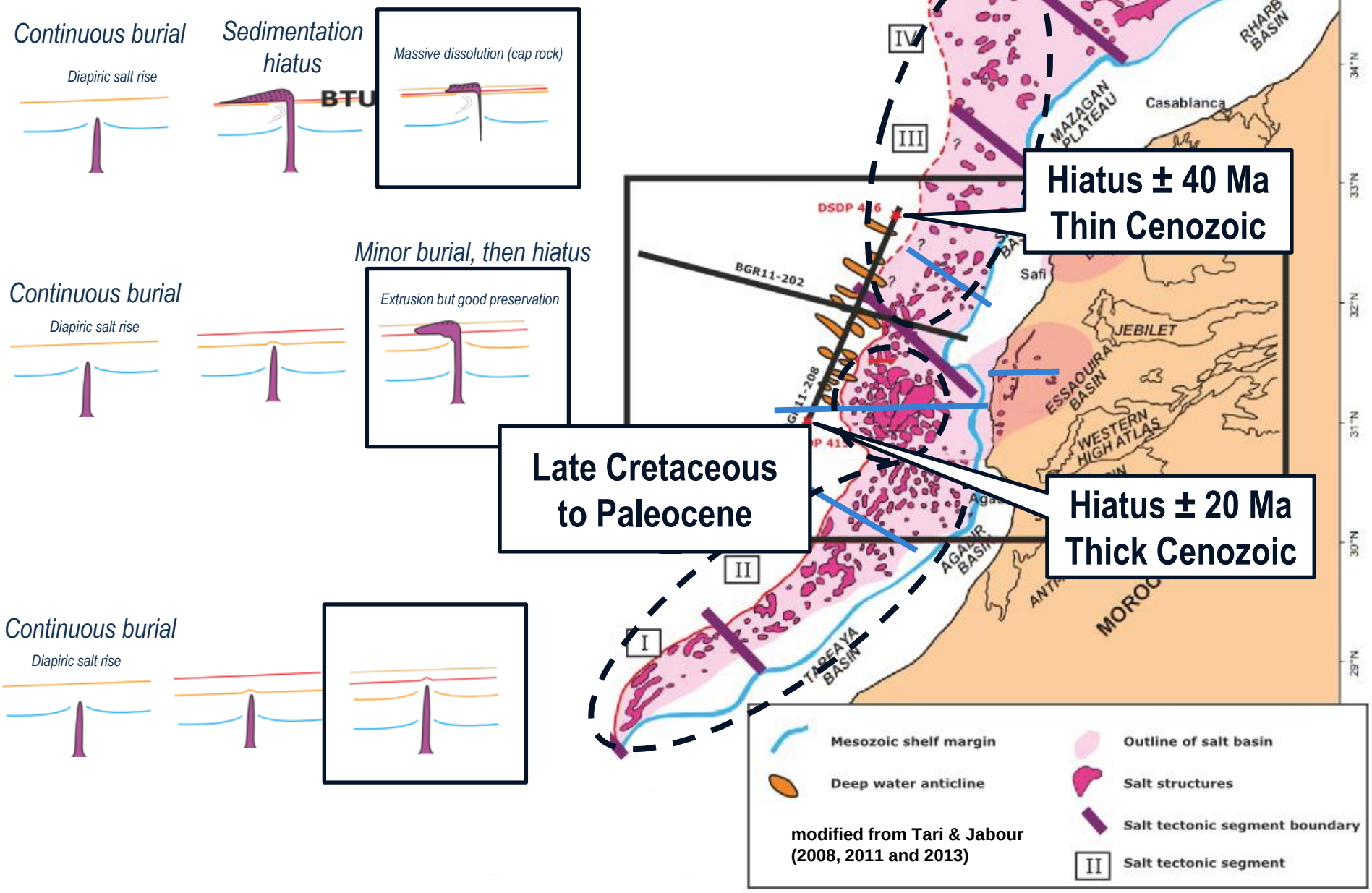

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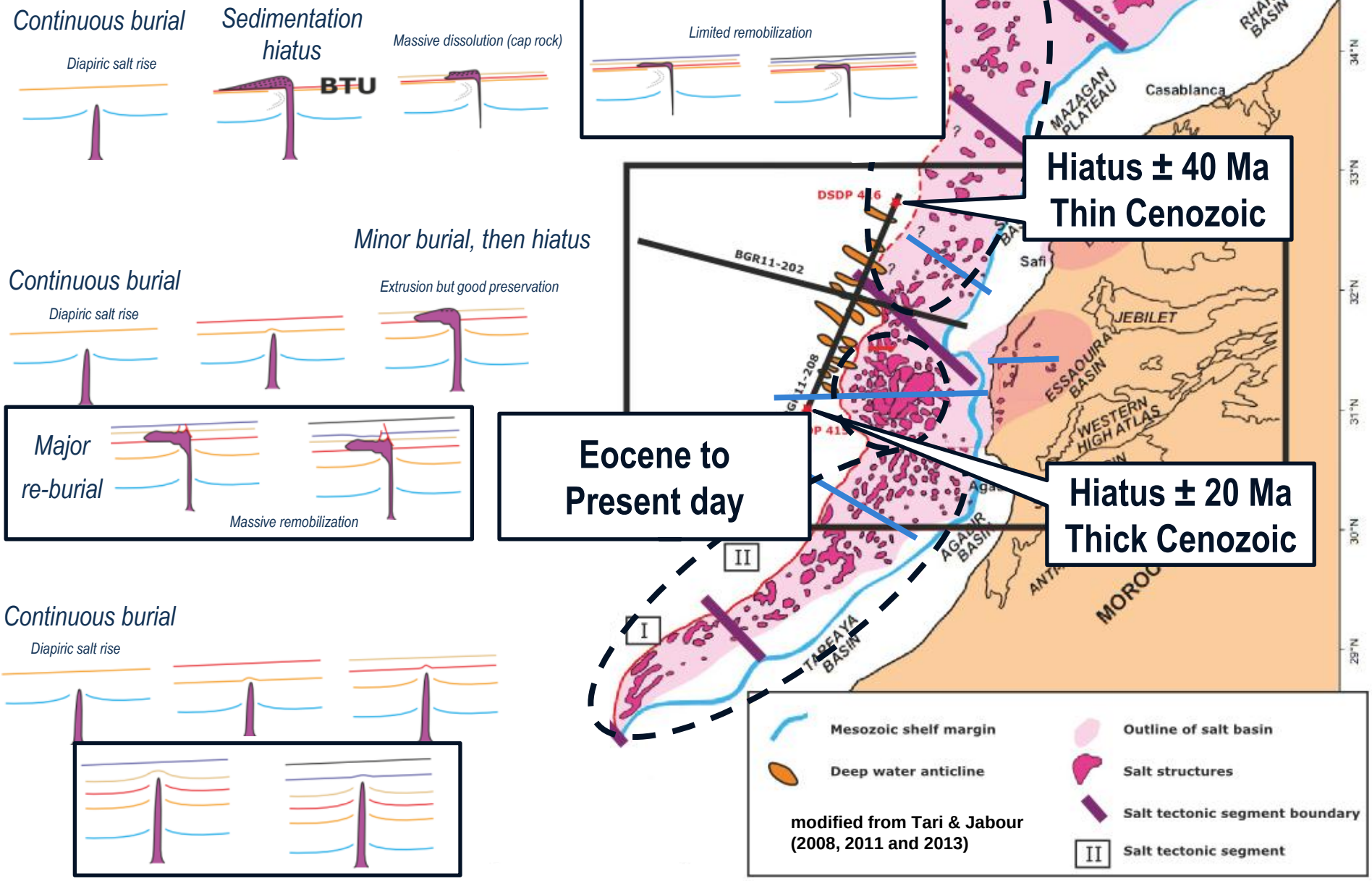
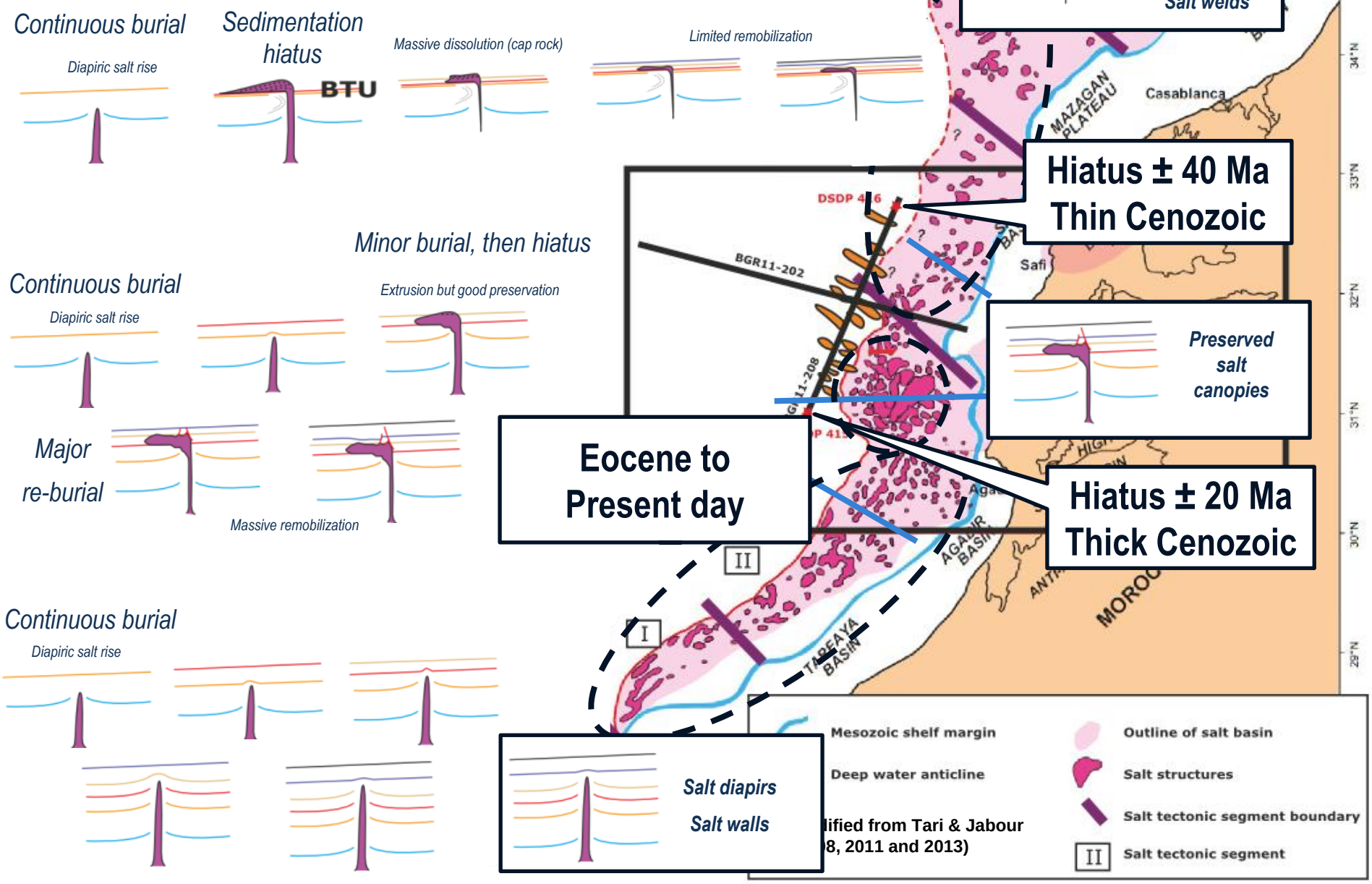
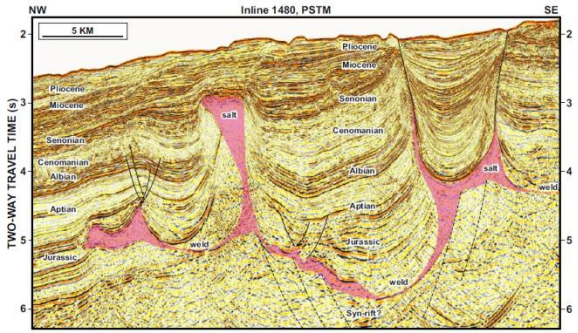
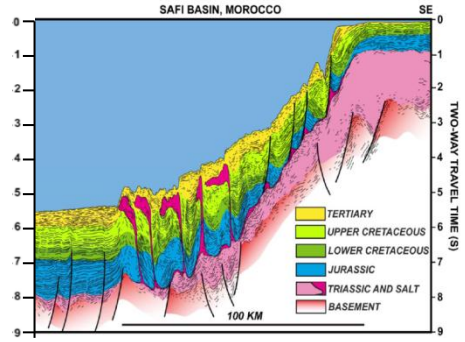


2. Salt Tectonics



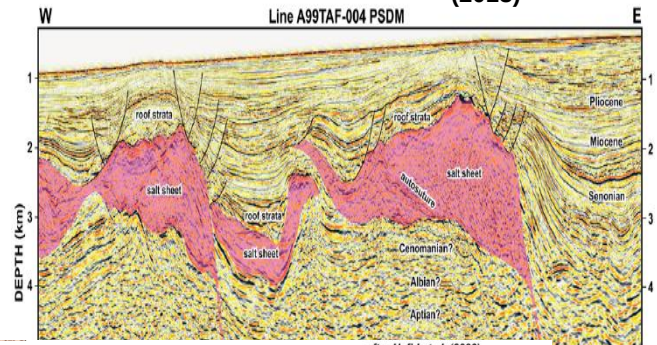
2. Salt Tectonics

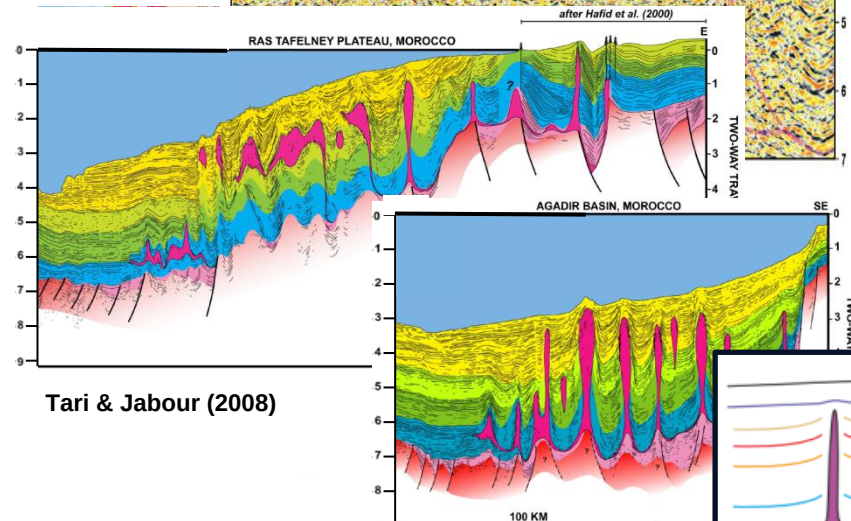




Tari & Jabour (2008)

Tari & Jabour (2013)





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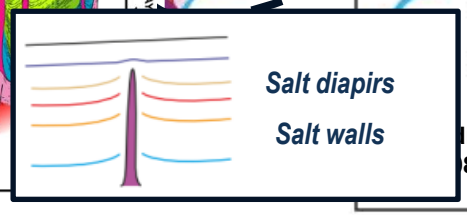
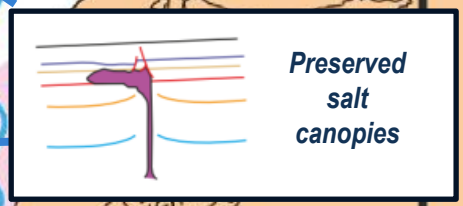


Hiatus ± 40 Ma
Thin Cenozoic

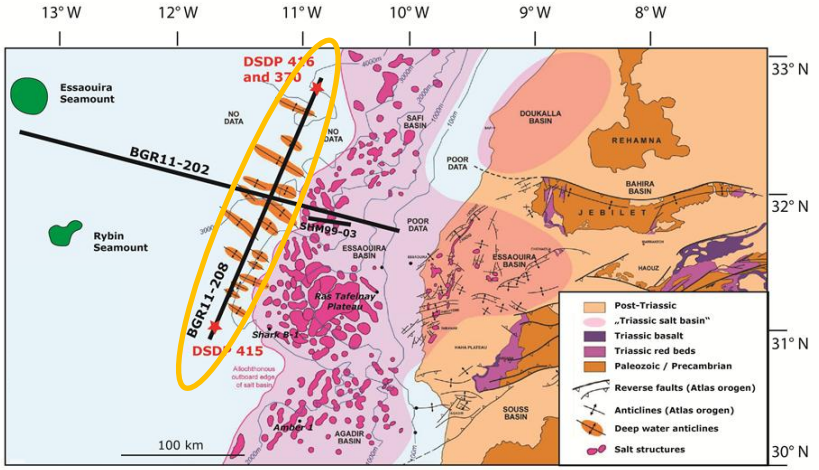


Hiatus ± 20 Ma
Thick Cenozoic

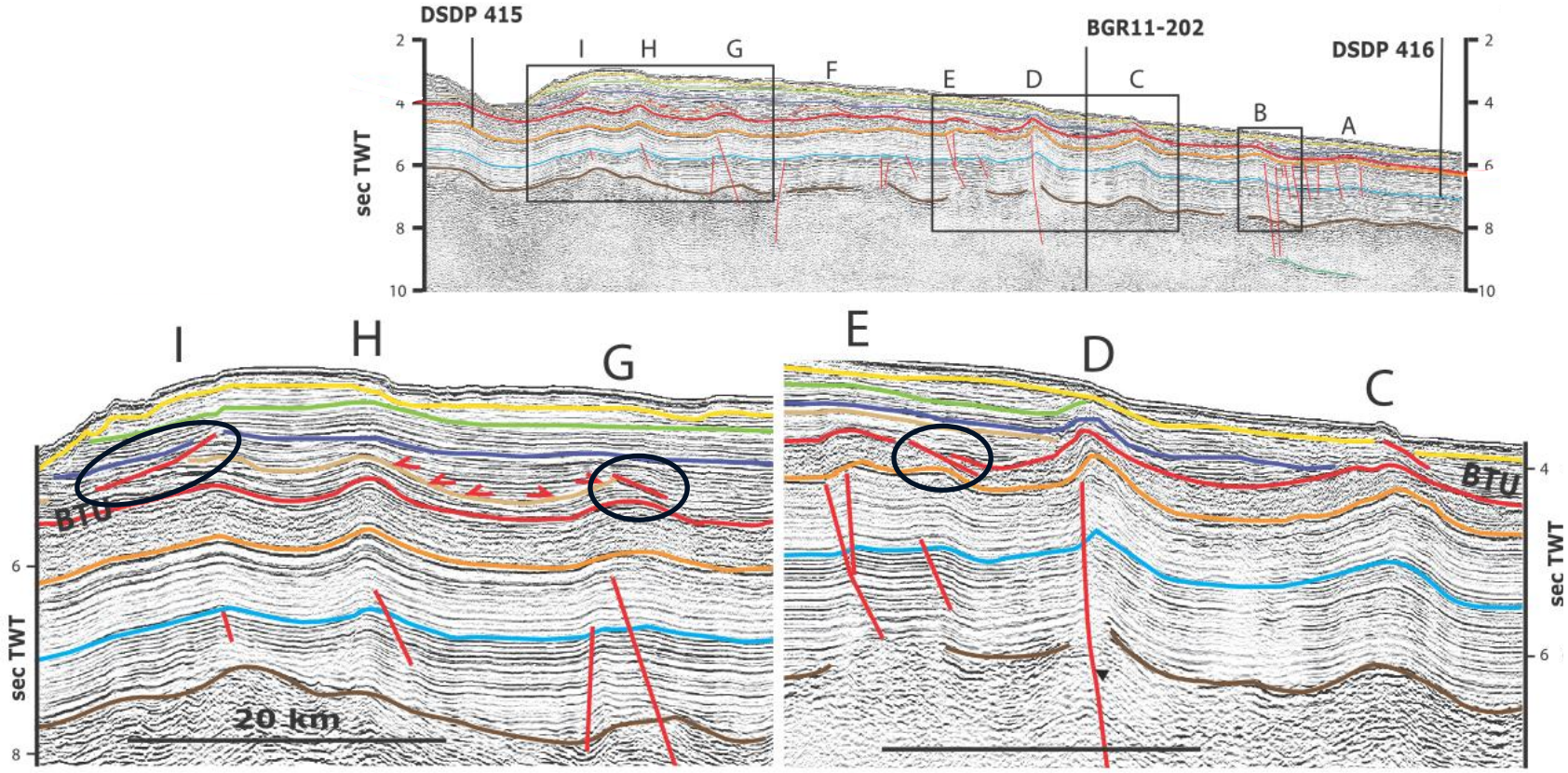
lified from Tari & Jabour
8, 2011 and 2013)

3. Deep-water Folds

- Overlying Basement Faults
- Associated with Gravity Faults

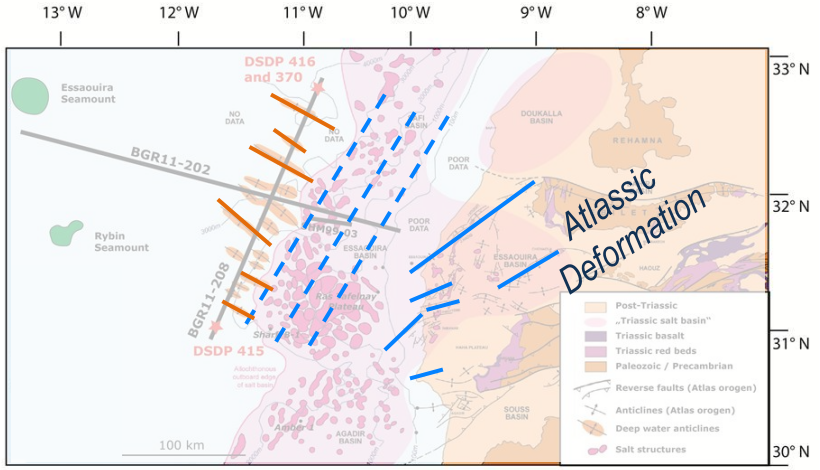


modified from Tari & Jabour (2008 and 2011)



3. Deep-water Folds

- Overlying Basement Faults
- Associated with Gravity Faults



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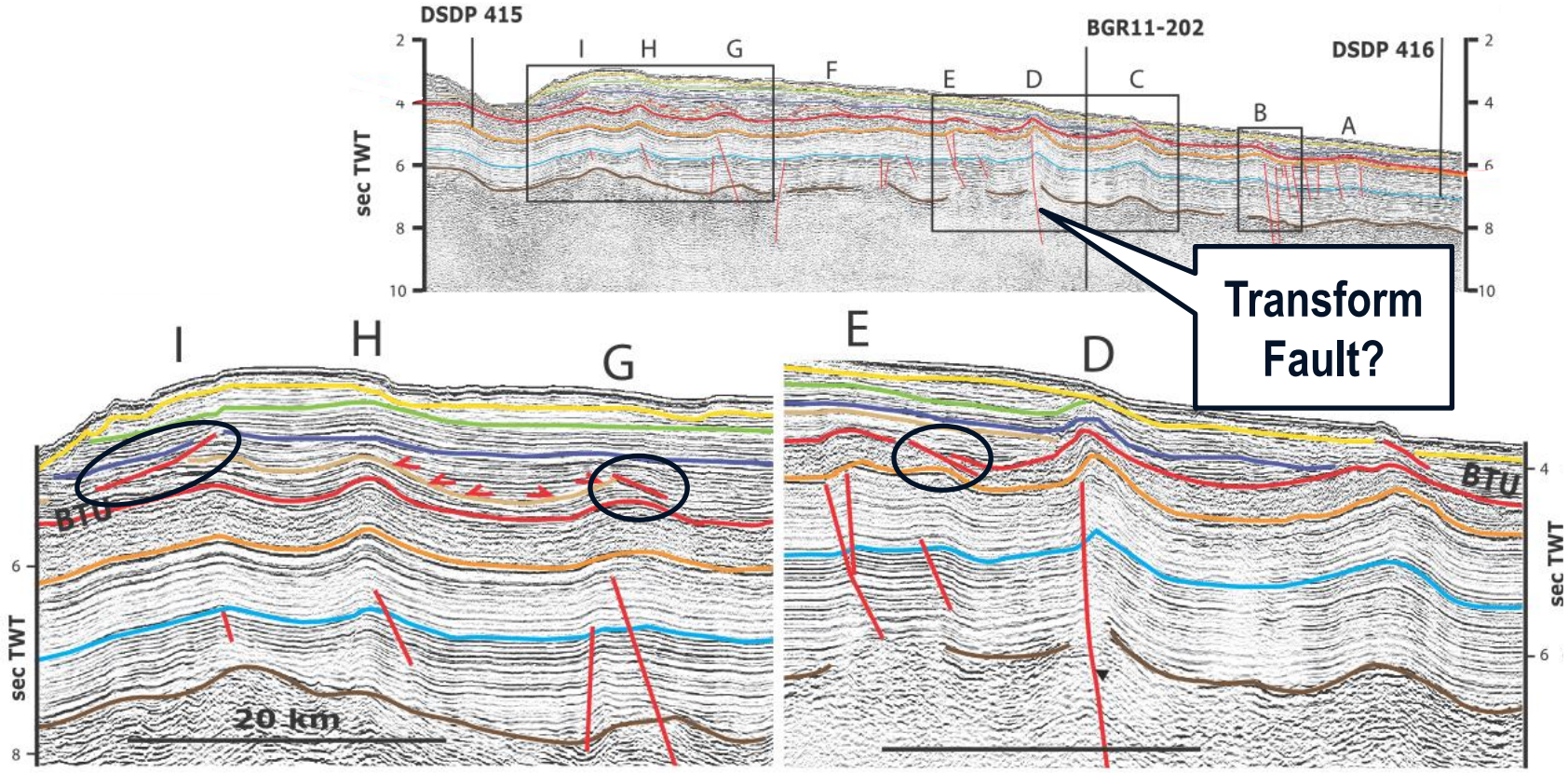
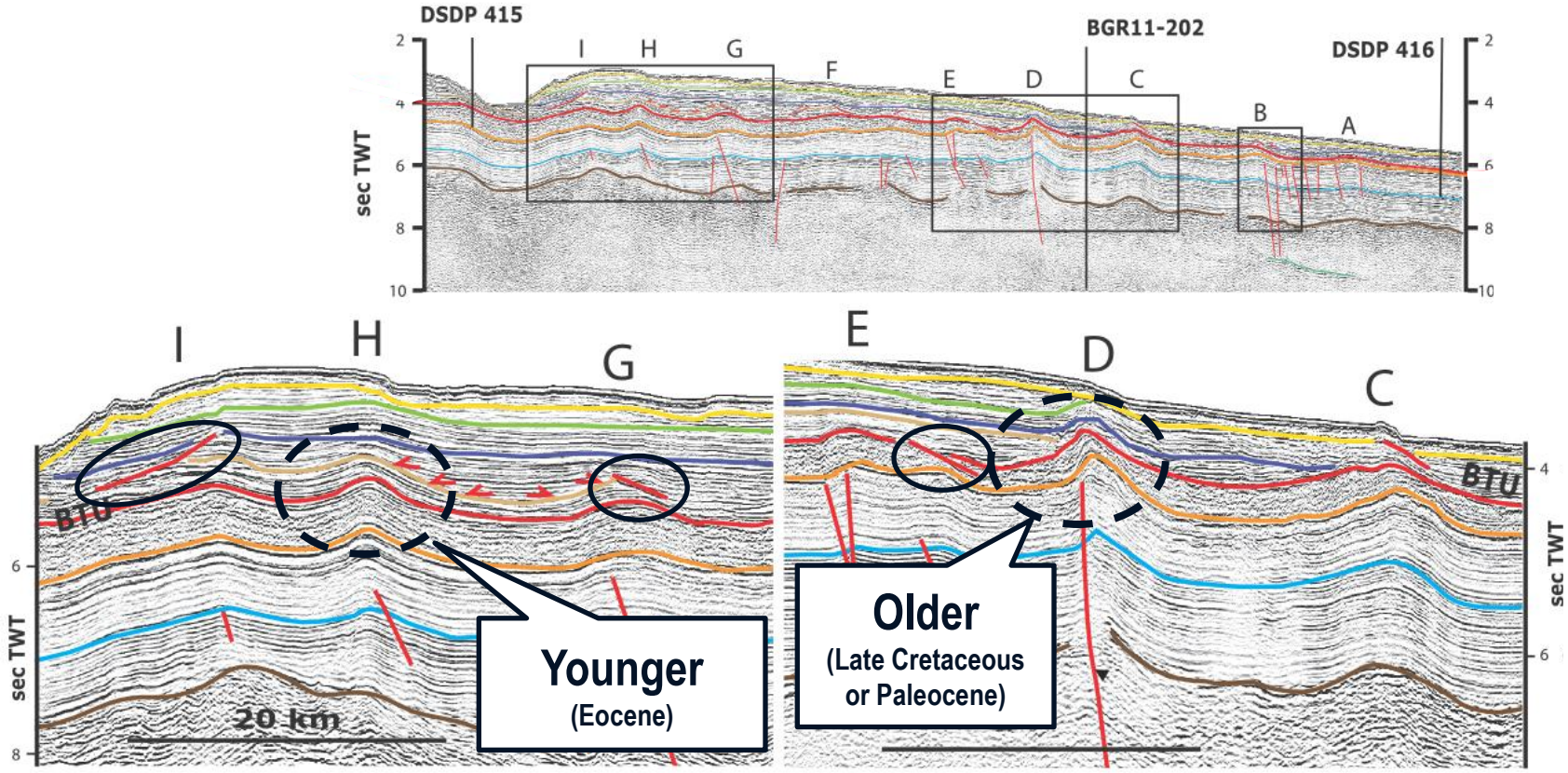


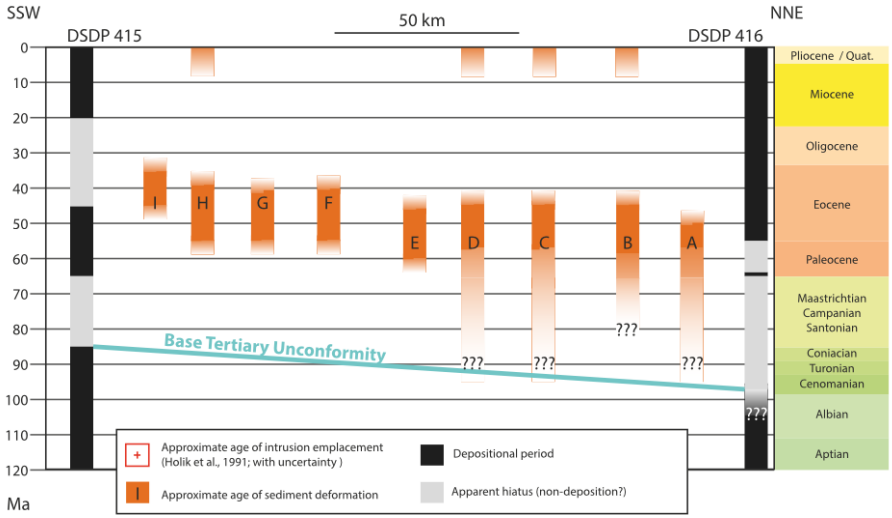
3. Deep-water Folds

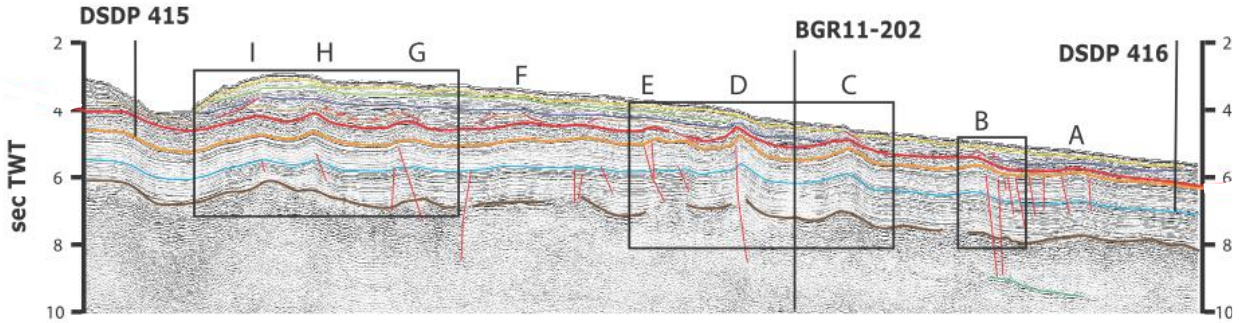
- Overlying Basement Faults
- Associated with Gravity Faults
- Diachronous Initiation

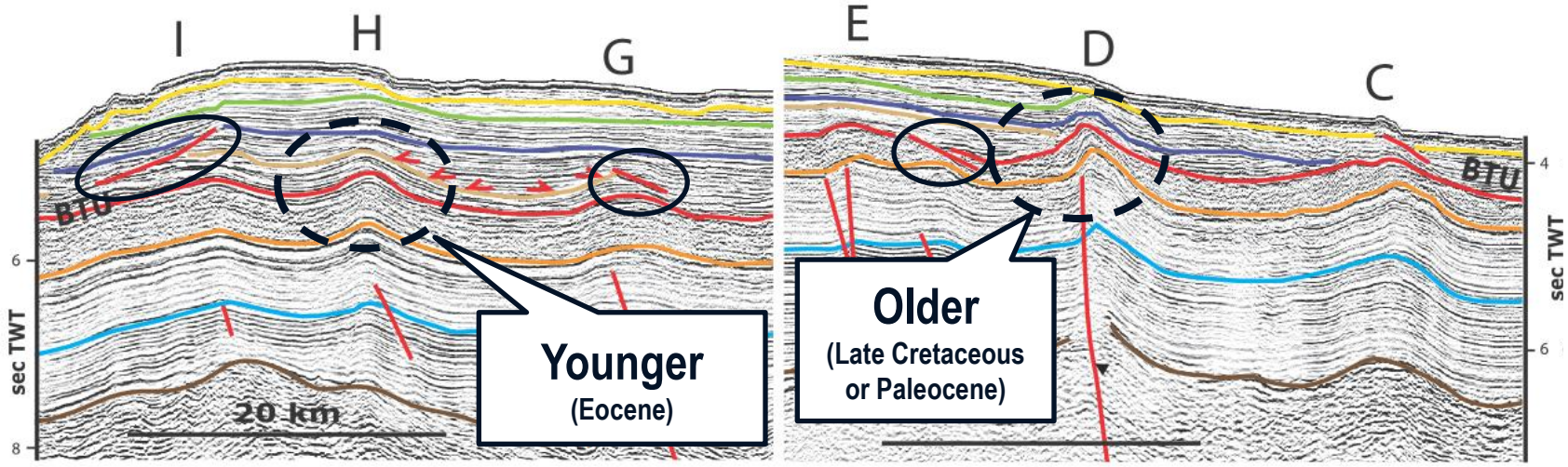


3. Deep-water Folds

- Overlying Basement Faults
- Associated with Gravity Faults
- Diachronous Initiation

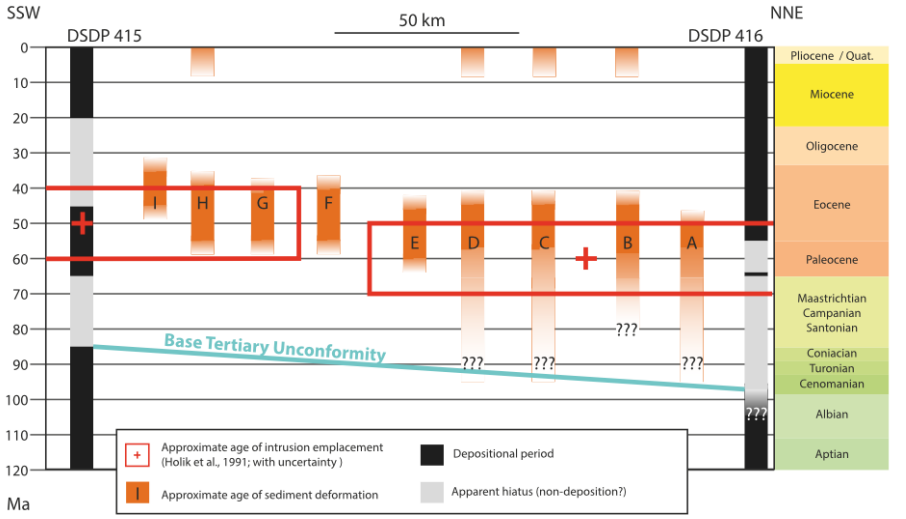


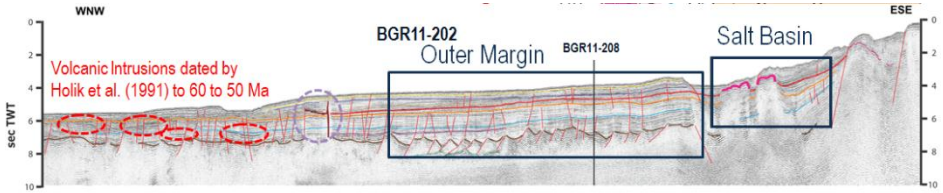


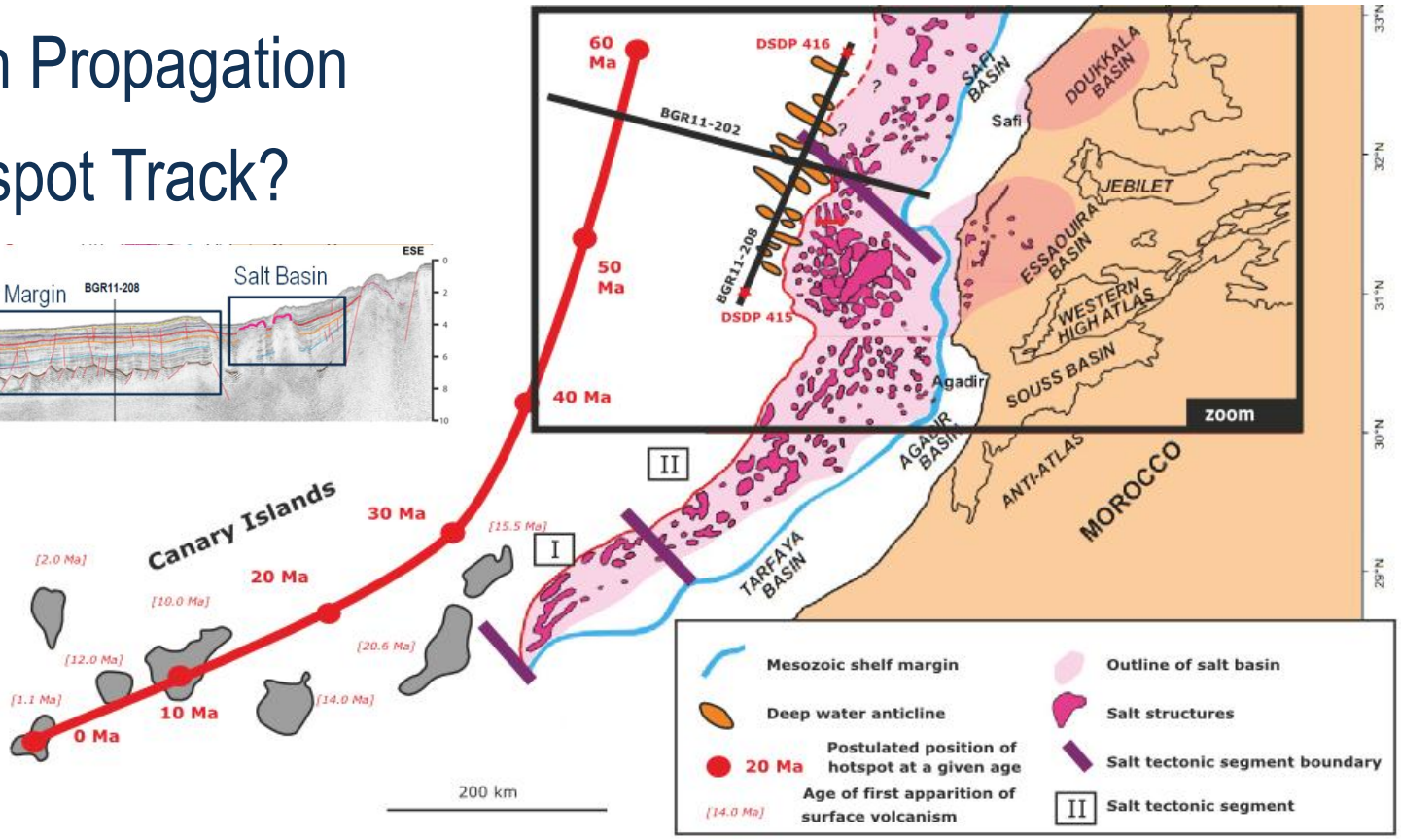


3. Deep-water Folds

- Overlying Basement Faults
- Associated with Gravity Faults
- Diachronous Initiation
- North-south Propagation
- Follow Hotspot Track?

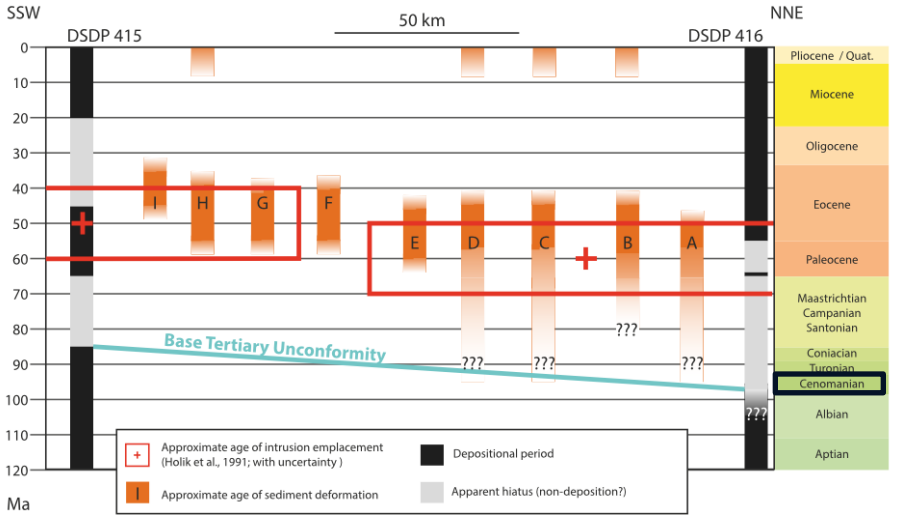


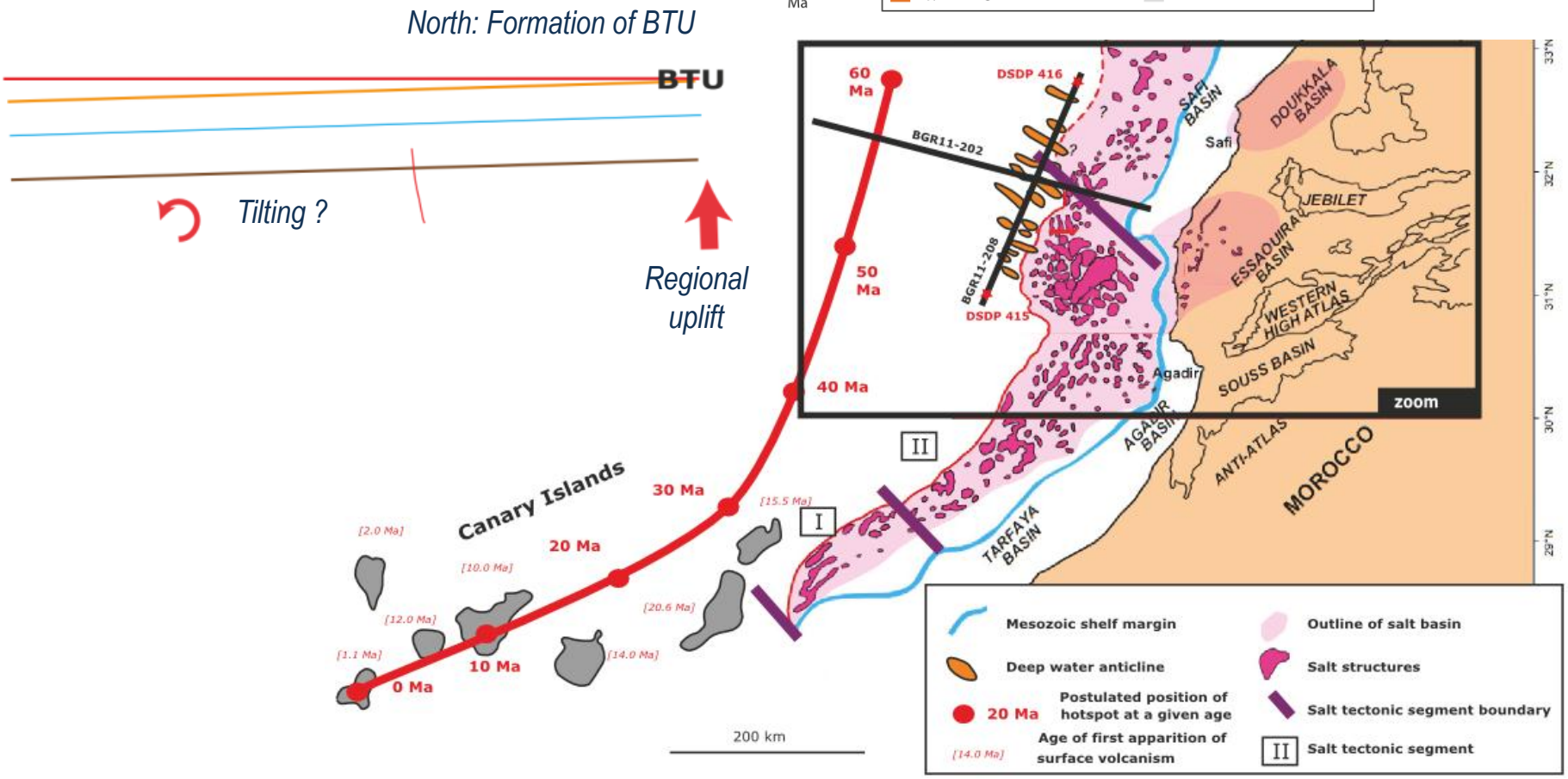




3. Deep-water Folds

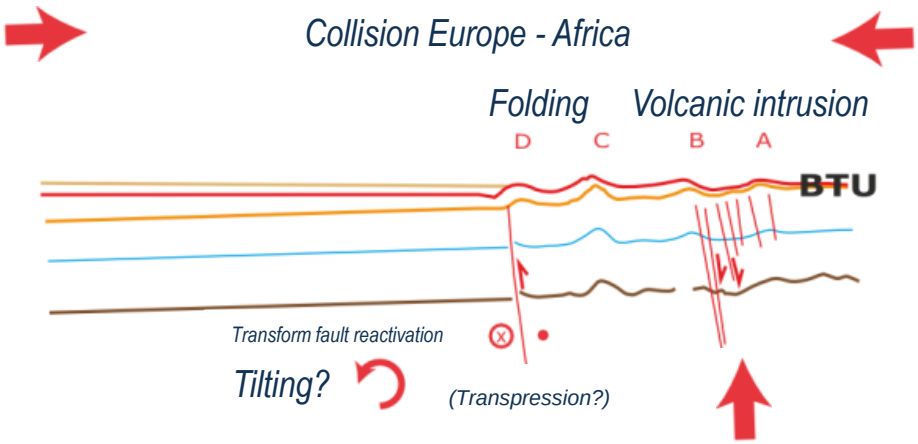
- Cenomanian to Coniacian

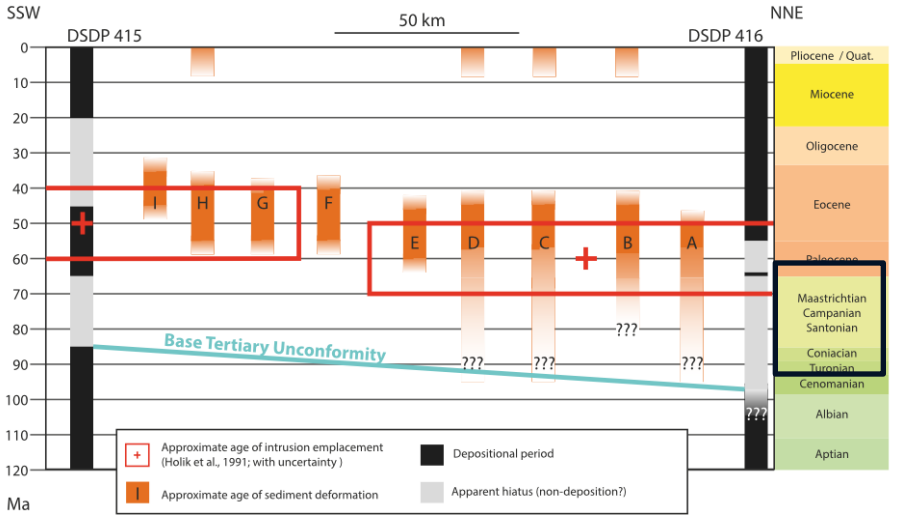


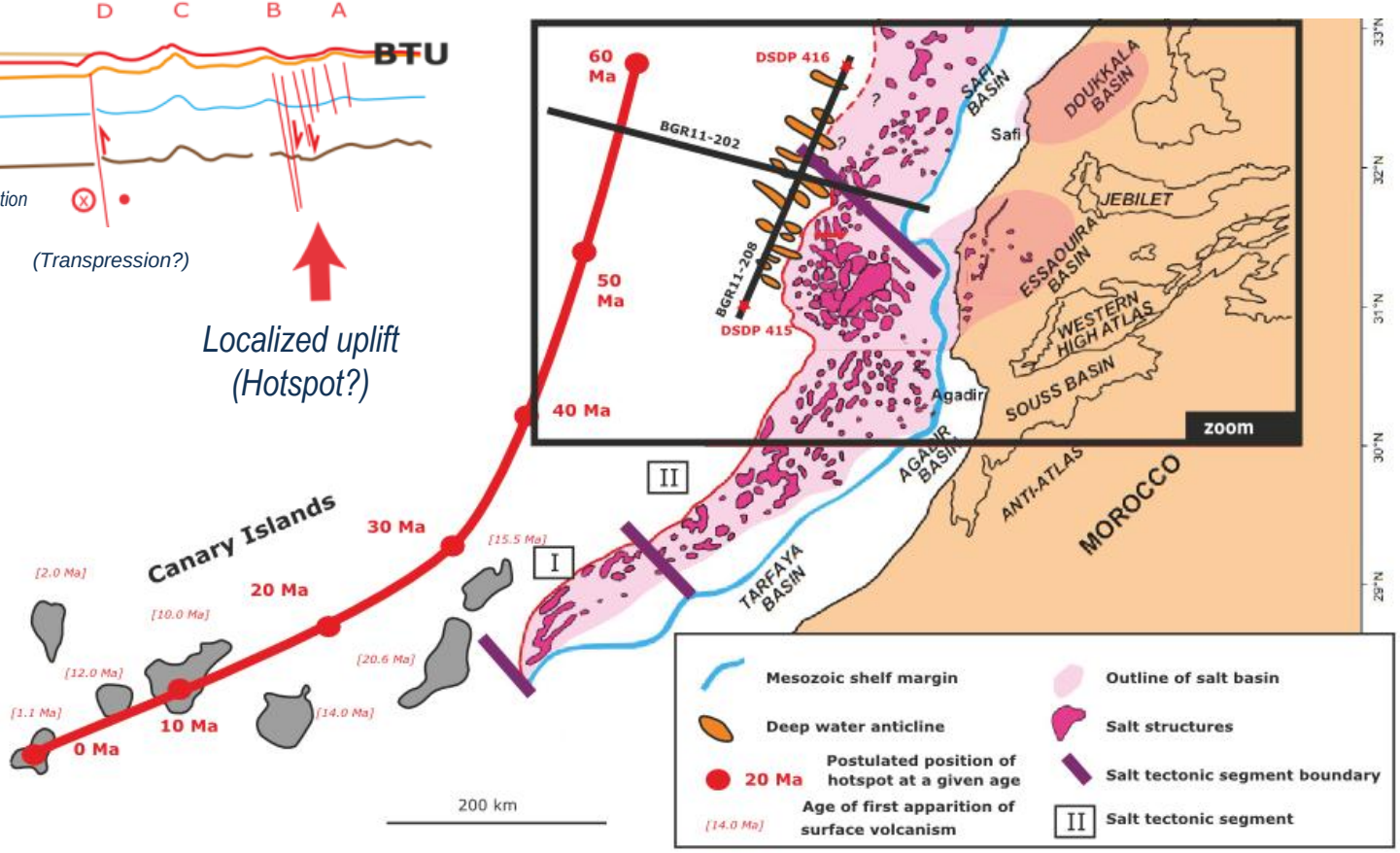


3. Deep-water Folds

- Late Cretaceous to Early Paleocene

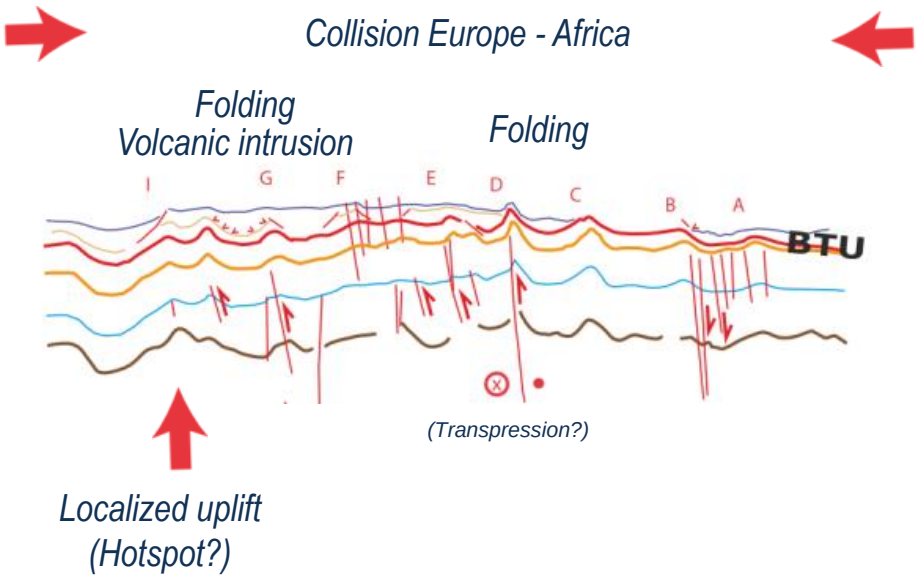


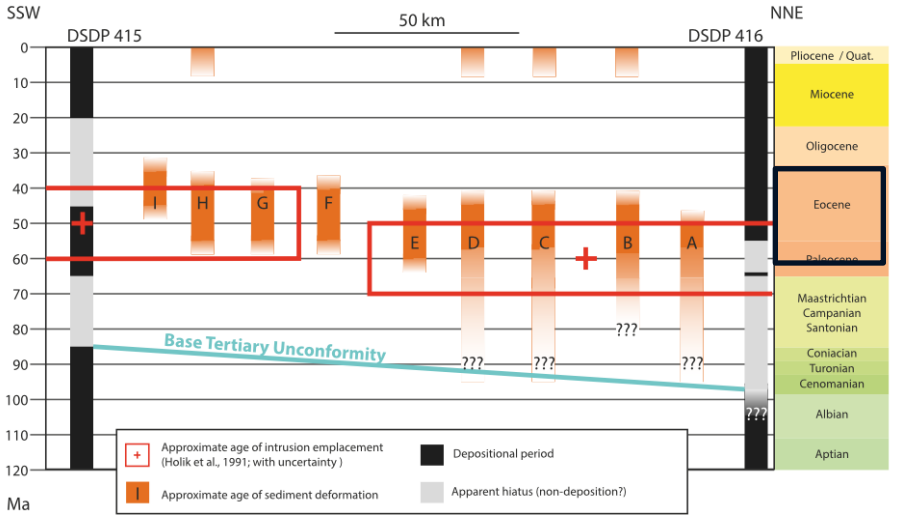


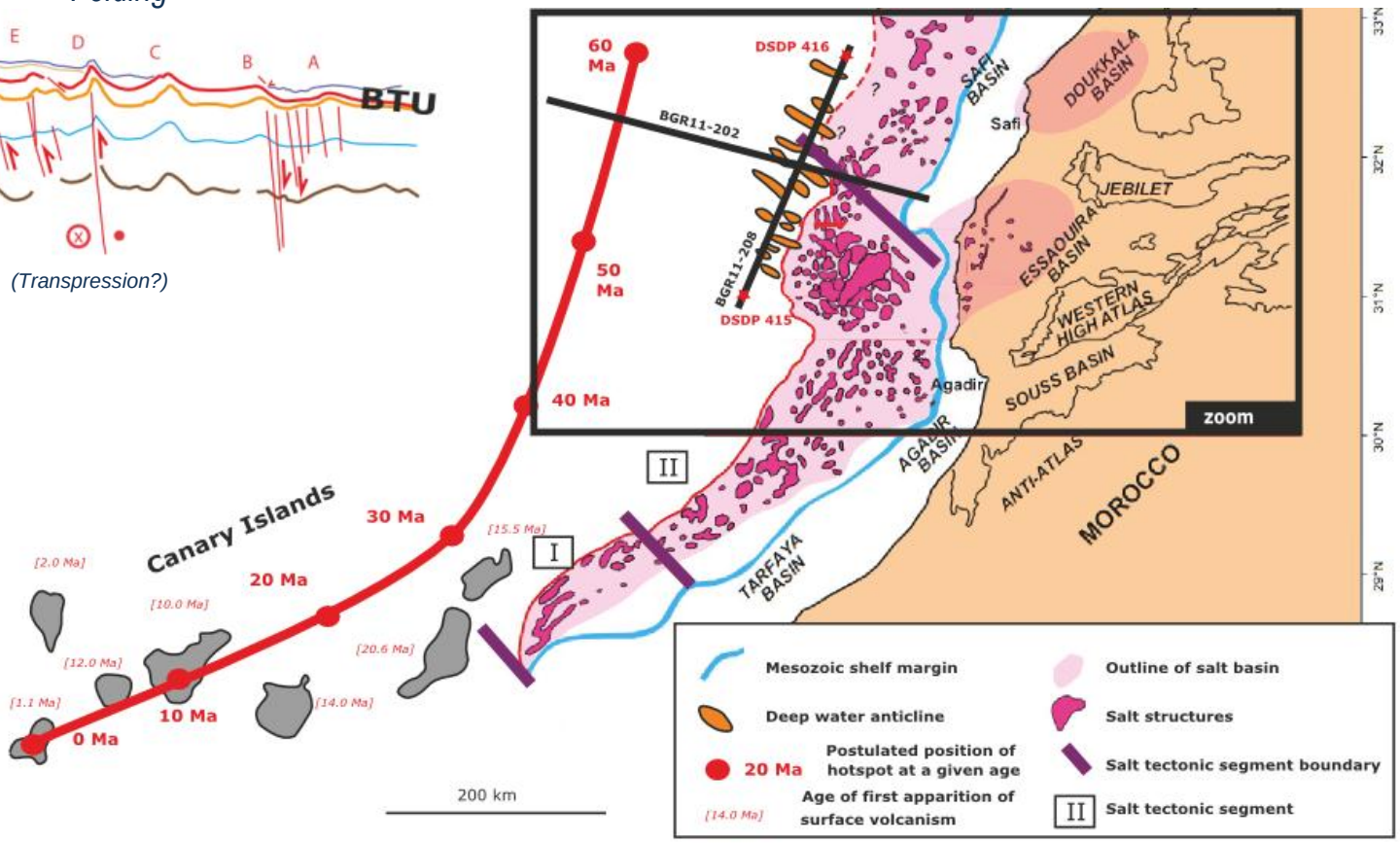


3. Deep-water Folds

- Late Paleocene to Eocene

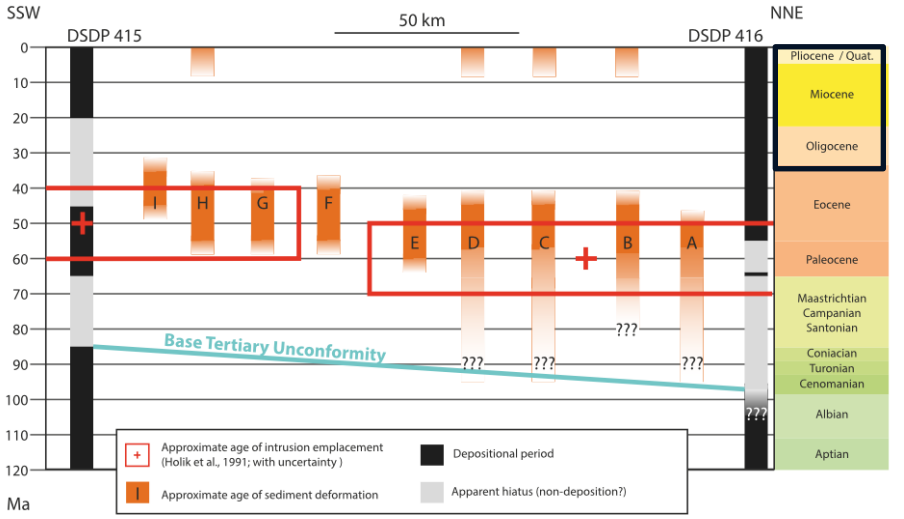


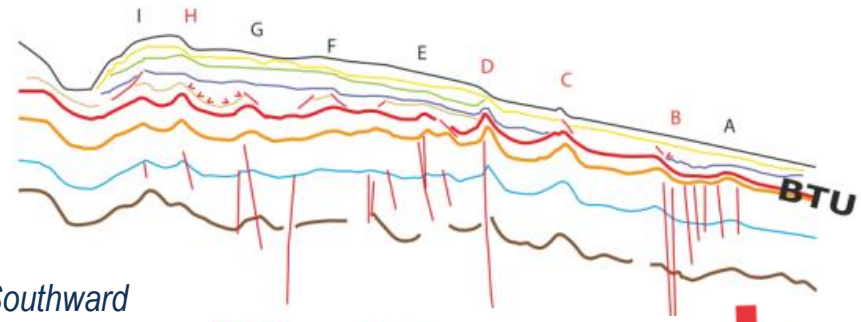




3. Deep-water Folds

- Oligocene to Present Day

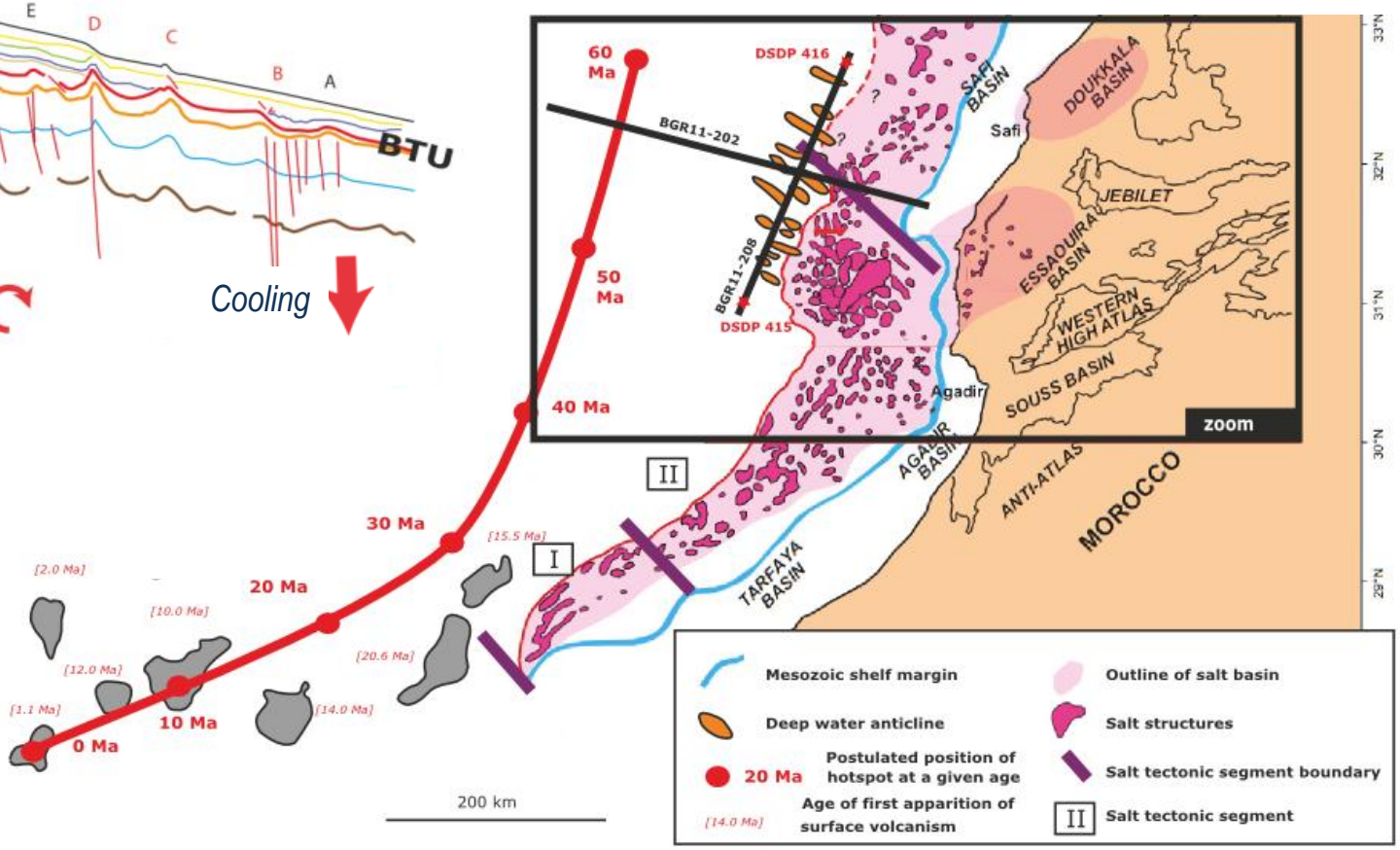




Southward migration of uplift

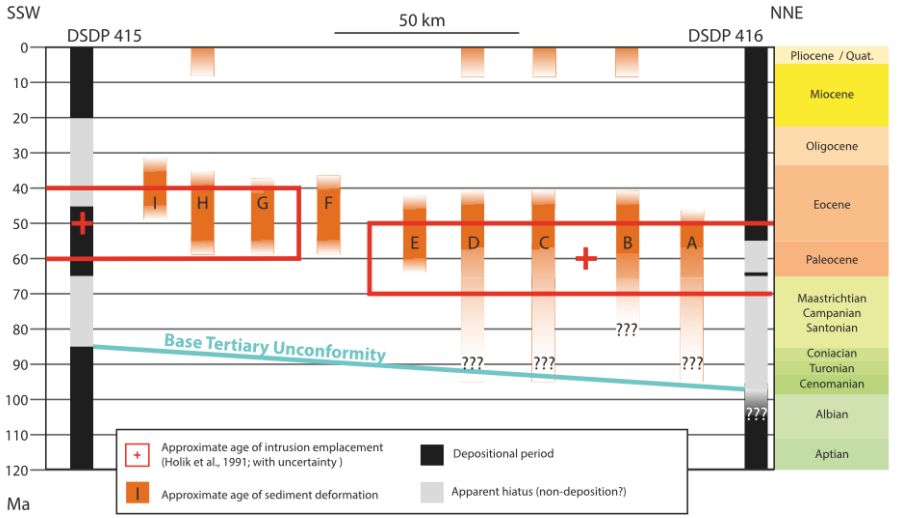
Tilting?

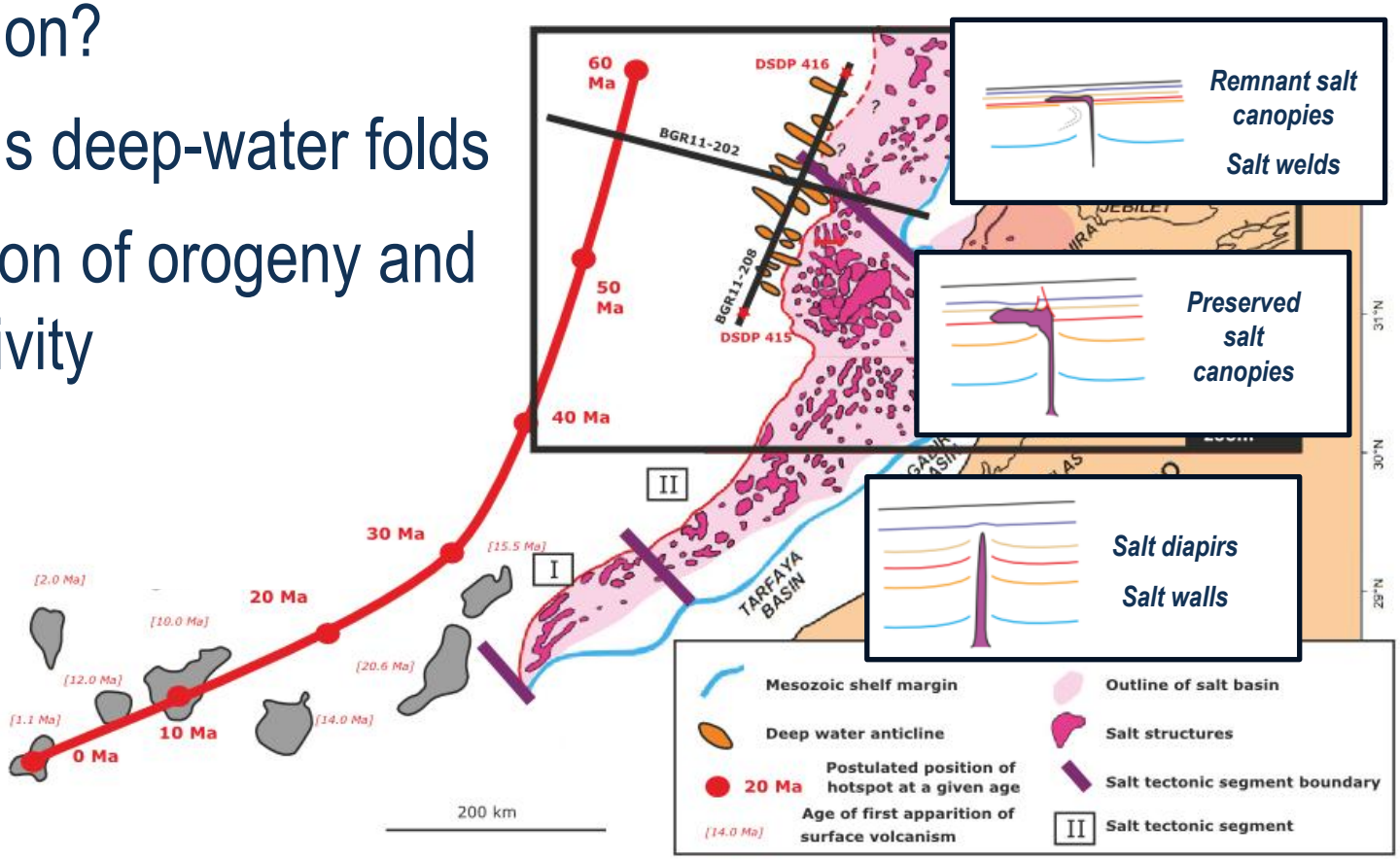
Cooling



Conclusions

- North-south variations along the Atlantic Margin
- Salt tectonics controlled by sedimentation?
- Diachronous deep-water folds
- Superposition of orogeny and hotspot activity





Acknowledgement

- Haddou Jabour and Salim Lahsini (ONHYM Rabat, Morocco) for the permission to use seismic data (“block E”)

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BGR

EMR Energy & Mineral Resources Group
RWTH AACHEN

Schlumberger